SCHOOL SCIENCE AND MATHEMATICS

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A PREVIEW OF THIS ISSUE

This issue is largely devoted to the report of the 35th Annual Meeting of The Central Association of Science and Mathematics Teachers held in Chicago, November 29 and 30, 1935, and to the papers delivered there. One of these addresses was published last month and others will follow in later issues. The splendid success of this meeting is indicated by the high caliber of the speakers who appeared on the program. Among them were the following whose papers are presented in this issue:

Professor E. J. Moulton, Chairman of the Department of Mathematics, Northwestern University. To mathematicians everywhere Dr. Moulton needs no introduction, but this was his first appearance on the general program of the Association. If you are inclined to be pessimistic with respect to the place of mathematics in the schools of the future, read his address on "The Future of Mathematics."

Professor H. O. Lathrop, Head of the Geography Department, Illinois State Normal University, delivered an illustrated lecture on "Human Geography as Related to the Zonation of Vegetation in the San Francisco Mountain Region." Lack of space permits reproduction of only a few of his instructive illustrations but the article is excellent even without the pictures.

Dr. F. R. Watson, Professor of Experimental Physics, The University of Illinois, delivered a demonstration lecture on "Selected Topics in Acoustics." The article presented in this issue is on a related topic. See the secretary's report for a description of the demonstration lecture. Professor Watson is one of the world's leaders in acoustical research, editor of the *Journal of the Acoustical Society of America*, and author of an excellent new college textbook on sound.

Mr. C. L. Schenk, Assistant Secretary of Sears, Roebuck and Company, gave a report on the use of the thirteen month calendar in business. This article does not deal in theories; it gives direct statements of how the revised calendar works in a great commercial establishment.

Professor Ira C. Davis, General Science Editor of SCHOOL SCIENCE AND

MATHEMATICS and Professor of the Teaching of Science in Wisconsin University, is known to all our readers.

Mr. Walter Carnahan, Head of the Mathematics Department, Shortridge High School, Indianapolis, is also a frequent contributor to this journal and to the Association program.

Miss Mary Melrose, Supervisor of Elementary Science in the Cleveland Public Schools, gave a description of a well-organized and executed plan for using the radio as a definite classroom teaching device.

A POSTCARD FROM THE PRESIDENT OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

GREETINGS:

Messages from the State Membership Chairmen are reassuring. Under the direction of Mrs. Wilcox, our efficient General Membership Chairman, the membership campaign is well organized and is moving along smoothly. Post cards are coming in from members who have succeeded in "selling" the Association to science and mathematics teachers. Thank you. Keep the good work up. Nothing succeeds like success. Hint: Leap Year IS a good time to secure new members. When you have obtained a new member be sure to send his name to your state chairman or to me in order that the "getter and the gettee" may be recorded in my "Pyrus malus" book. Mr. Christie in Cincinnati is to be highly commended for the fine constructive work he is doing.

A note to the chairmen of the Section Meetings: Will you please obtain speakers for your section real soon and send me your program for the meeting as you wish it to appear in the year book? Some of the speakers for the general meetings have been engaged. I will tell you about them later.

A note to the boys and girls who are studying biology: February brings a number of days that are of special interest to biologists. To begin with the ground hog or woodchuck (Arctomys monax is his dress up name) has his "coming out" day on February 2. If your school is located in a region where this interesting rodent lives, your class will have an "excuse" for taking a field trip to see if there are tracks near the entrance to his den. If tracks are in evidence, it is likely that the 'chuck has awakened from his long hibernation and has come out to stretch himself and to find food. Of course, we know that "seeing his shadow" has nothing to do with the kind of weather we are to have during the next six weeks. This suggests an interesting topic for a round table discussion, viz.: Superstitions in Biology. (Dr. O. W. Caldwell's book *Do You Believe It?* Doubleday Doran, will help you with your discussion.)

The birthdays of Lincoln, Washington, Darwin, Longfellow, Lowell and other naturalists come in February, also St. Valentine Day. Question: In

what ways was each of these men a good biologist? Suggestion: It would be good fun to prepare a list of the great biologists, nature writers and nature poets who have contributed to biology whose birthdays come in February. A promise: An interesting souvenir will be presented to the biology class that prepares the most complete list of "February Naturalists" giving reasons in each instance why the name was included in your list. This should reach me before the first day of spring.

Sincerely yours,
O. D. FRANK,
The University of Chicago
Chicago, Illinois.

EVIDENCE FOR EXISTENCE OF NEUTRINO PRESENTED BEFORE PHYSICAL SOCIETY

Experimental evidence for the existence of the "neutrino"—postulated but never-found new atomic particle—was presented by Dr. Kenneth T. Bainbridge of Harvard University before the meeting of the American Physical Society.

For years scientists have known that the cores, or nuclei, of atoms contained the electrons, the negatively charged particles of small mass, and the protons which are positively charged particles of the same mass as the hydrogen.

In 1932 Prof. James Chadwick of Cavendish Laboratory, England, discovered that atom nuclei also contained the neutron which, as the name suggests, is neutrally charged in the electrical sense. Prof. Chadwick won the 1935 Nobel Prize in physics for this discovery.

More recently a number of theoretical scientists have postulated the existence of the neutrino, or little neutron, in order to explain certain products produced in artificial radioactive transmutation of the elements.

Working from known facts and with known theories it can be shown, for example, that certain isotopes can exist only if the neutrino is a fact instead of a mathematical abstraction. The search for such isotopes would, then, constitute a test for the existence of the neutrino.

Dr. Bainbridge's report concerned the discovery of what might be called the "neutrino" isotopes. Using his new mass spectrograph—which might be likened to a super scale for weighing individual atoms—the Harvard scientist detected isotopes of cadmium and indium of atomic weight 113, indium and tin of atomic weight 115 and antimony and tellurium of atomic weight 123. These isotopes can exist only if the neutrino exists.

The experimental technique is an indirect one, naturally. It is about like saying that all living bodies must contain hearts and if you can find a living body you have evidence for a heart inside it, even though you may not be able to see the heart itself.

SUGAR FROM THORNS IN U.S.S.R.

Sugar in paying concentration has been found in the sap of a species of camel-thorn abundant in a central Asian desert area some six or seven million acres in extent. The Soviet government has established two extraction plants in the province of Uzbekistan.

THE FUTURE OF MATHEMATICS

By E. J. Moulton
Northwestern University, Evanston, Illinois

Introduction

My subject, the future of mathematics, is a large one, probably endless in time and boundless in extent. Whether this makes its domain infinite, or whether like current theories in imaginative physics the space-time manifold of mathematics is finite, it is obvious that I must limit my remarks today to certain features only of the general topic, and I ask your indulgence in allowing me to follow my particular present day interest.

As a further introductory remark, I may add that when one talks of the future of mathematics, he is functioning less as a mathematician than as a theologian. For obviously one cannot prove his statements in a mathematical sense, but must rather resort to judgments, analogies, beliefs, hopes, and prayers. This is difficult if not distasteful to a mathematician, to whom the degree of perfection attained in mathematical arguments is a prime source of pleasure, if not indeed the greatest motivating force in his pursuit of mathematical studies. And yet it behooves a mathematician to give thought occasionally to the future of his science if its welfare is to be guarded.

In the present paper, I shall say a few words about three aspects of the future of mathematics. These may be indicated by the captions:

1. Research, mathematics as a living organism.
2. Curriculum, the place of mathematics in our educational system.
3. Teaching, the transmission of mathematics to the future.

Research

What is the future of mathematics as a body of knowledge? Will there continue to be mathematical research? Will mathematics continue to be a living, growing organism, or will it become mature, full grown, and then pass on to senility and death?

These questions may be considered from the point of view of the distant or of the immediate future. The distant future is largely an academic question with which we may amuse our-

selves just as physicists and astronomers may divert themselves with speculations regarding the structure of the universe in its entirety. (You know how we get reports concerning the diameter of the universe, or the date on which it was born, or the length of time before it will run down and become cold and lifeless!) Let us open our discussion with such an inquiry into the distant future of mathematics as a body of knowledge; as I have intimated, this is not to be taken too seriously.

In the first place, the field of mathematics has been constantly growing and at an increasing rate. During the last decade a thousand doctor's theses in pure mathematics have been written, and probably ten times as much research has been completed by maturer mathematicians. The publication of all of this output, estimated conservatively, fills two hundred large volumes. This is probably a fifty per cent increase in productivity over the preceding decade. To be conservative, assume that in the future the increase averages only ten per cent from decade to decade. We can now calculate the output in future years. A thousand years hence mathematicians will turn out research at the rate of 37,000,000 volumes per decade; if these books were placed end to end they would reach from Ann Arbor, America, to Addis Ababa, Abyssinia. And ten thousand years from now, a time not much more distant than that of Noah's flood, the annual output will be 5×10^{42} tomes, to store which will require a library which if cubical in shape will have an edge as long as the distance from the sun to the planet Neptune. And if we look forward to a time as remote as that of our Neanderthal ancestors, the output of research in mathematics will fill several times annually the whole finite universe handed to us by the speculative physicists.[1]

I hope that you will take neither me nor the speculative physicists too seriously, for our computations were based on assumptions which, though compatible with a certain body of observations may have overlooked something significant in large

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[1] Perhaps by that time mathematicians will have invented a notation so effective that what now requires volumes to state will be condensed into a single small symbol, and books will be written entirely in terms of such symbols; perhaps printers will succeed in publishing these extensive works in miniatures the size of atoms; perhaps librarians will learn to store these miniature books so that they are in actual contact with each other, not far apart like the atoms in a piece of lead; even then if mathematical output increases according to the law we have stated, ten million years from now the output will be so great that the whole of the physicist's finite universe will be filled with these books in far less time than it takes light to travel from a molecule to its nearest neighbor. Large as this output is, the mathematician will insist that it is finite and no nearer infinite than the present output of a few hundred volumes.

scale phenomena, and our conclusions are not valid if such is the case. The nature of our conclusions, of course, leads us to believe that this is the case; in fact it is fairly obvious that the rate of output cannot continue to increase over any great length of time, and judging by analogy with the history of outbursts of other forms of human activity, it seems certain that the future will see mathematical depressions as well as economic depressions. My guess is that the accumulated store of mathematical knowledge will become so great inside of a century or two, that even if conditions for mathematical study are otherwise propitious, advanced pure mathematics will no longer attract the vigorous attention it now receives.

Let me now restrict myself to the more immediate future where the uncertainty is not so large. What can we predict for mathematical research in the next fifty or a hundred years? Even here the effects of unknown future conditions may be decisive. A prolonged world war may destroy our civilization and put an end to our creative activity. An overthrow of our government may bring to power persons antagonistic to all scientific activity, persons who not only will advocate a moratorium on scientific study, but who will make the pursuit of science a criminal activity. A wave of educational iconoclasm may cause educational leaders in true Cromwell style to cast out those things which have been highly regarded by their forerunners in favor of some new ideal, and mathematical research may disappear in the resulting turmoil. Economic disasters may bring financial ruin to our schools, all forms of education may suffer, and in particular, those forms not regarded as practical by those holding political power; and mathematics may be seriously crippled. These are some of the lugubrious possibilities. As far as I know, it may happen that diametrically opposite influences may develop. Perhaps forces working for peace, prosperity, and pursuit of knowledge will have signal success; perhaps educational theorists in their perpetual swings backward and forward will decide to place mathematics in an especially favored category; perhaps mathematical successes will bring into mathematical research activity an enthusiasm never known before; perhaps some or all of these beneficent influences will conspire to render the next fifty years the golden age of mathematical science.

Recognizing the uncertainties, let me make my guess concerning mathematical research in the near future. First, I

would say that the supply of mathematical geniuses, or at least persons with great mathematical power, will not be lacking. Those of us who have seen the unending stream year after year of gifted students entering the universities will unanimously vouch for the quality of the material and its unceasing supply.

Second, I would say that the enthusiasm of brilliant students for mathematics will not abate. This is evidenced by the recent marked increase in enrollments in advanced courses in mathematics, and is fortified by the conviction that mathematics most fully satisfies two fundamental traits of human character, curiosity and the desire to reason.

Third, I would predict that America will take the lead in mathematical activity. Even during the years of depression we have added two to our former five mathematical journals devoted to research; the last decade has seen a marked increase in membership in the American Mathematical Society; a number of distinguished mathematicians have come to America from Europe; and the research center at the Institute for Advanced Study at Princeton has crystallized and intensified the interest of American scholars in mathematical research. The facts augur well for the future of mathematics in America.

In the past, research activities in mathematics have centered almost exclusively in the universities. I foresee a broader field of activity ahead, with numerous industrial research organizations, governmental agencies, and research institutions devoted to social and biological sciences as well as physical and mathematical sciences, adding mathematical divisions to their staffs. Already a tendency in this direction is discernible.

As to the particular direction in which research may go, I hesitate even to make a guess. History shows how, in the past, fruitful ideas have turned the course of inquiry into unpredictable channels. A century ago non-euclidean geometry made its appearance, with no great acclaim, and it received little attention even from mathematicians for several decades. Eventually, however, it has revolutionized in fundamental respects basic ideas not only of mathematicians but also of philosophers and physicists, leading, for example, to Einstein's theory of relativity. Who knows what realms of knowledge may develop from some recent mathematical contributions? Five years ago a paper appeared which may be of revolutionary significance; it questioned the laws of logic at the foundation of mathematics, and argued the equal validity of other logical systems. It is

not difficult to see the possible tremendous import of this idea, not only for pure mathematics, but also for all science in which the laws of logic are used. Perhaps, however, some paper of which I have not heard will prove to be of even greater significance. Perhaps the mathematical tools are being forged which will enable us to formulate a satisfactory theory of the weather, much as the development of the ideas of differential calculus enabled Newton to work out his explanation of the movements of the tides and of the moon, planets, and stars. Perhaps tools are being shaped which will aid the physiologist in solving some of his extremely complicated problems, and prove the key to formulation of fundamental laws of biology. Perhaps weapons of attack are being invented which will help to bring our economic system into a more orderly state, certainly an end most seriously to be sought. Perhaps—but I must not stop longer for these speculations, for I wish to speak about other things with which this audience is more directly concerned.

I will only add with regard to the research phase of mathematics that in both pure mathematics and its applications the development in recent years has been extremely vigorous, that it is clearly becoming more and more important, directly and indirectly, in the development of science—physical, biological, and social—of pure science and of applied science—and that you who are teachers of mathematics are contributing an essential element to the furtherance of this valuable research activity.

Curriculum

In turning now to the place of mathematics in the curricula of our schools, we enter a field about which so much has been said by so many people that I am inclined to shrink from joining the babel. And yet a discussion of the future of mathematics on an occasion like this would be notably deficient if the question were not taken up.

The problem is becoming constantly more complicated by the fact that changing economic conditions are delaying the entry of youths into industry to later and later years. Where a generation ago a boy might leave school and go to work at the age of twelve or fourteen years, he must now wait until he is sixteen or eighteen or twenty. These adolescent years from twelve to sixteen or eighteen, must be spent in school. Thus in a very serious way our high schools are becoming a combination

of a school (in the older sense) and a civilian concentration camp. The problem is also being passed on to the colleges to some extent for where we previously had tens of thousands of young men and women in these higher institutions of learning we now have approximately a million such students in the United States.

We seem to be definitely committed in this country, for the present at least, to this wholesale education, though it is worthy of note that in some of the European countries a different philosophy of education is being developed. It is not at all certain that it is for the best interests of our nation, either as a nation, or in terms of its individual citizens, that the educational system should be geared to include all persons under twenty years of age. It might well be that the two primary functions of our school system at the present time—the school function and the concentration camp function—should be divorced. Germany has gone a long ways in this direction at the college level in sharply reducing the number of students that may be admitted to her universities. Without necessarily following Germany's lead, we may well question a policy which tends to reduce the morale of the better students by submerging them in a sea of mediocrity, and to shatter standards of education by practically requiring teachers to pass students on to higher grades on the basis of physical maturity or a period of residence.

Today I must assume that these two functions of the school—the school function and the concentration camp function—are not to be divorced. Under these circumstances, what should be and what will be the place of mathematics in the curriculum? The answer is different, I think, for different levels of the school system.

In the elementary school, I think all should agree, the fundamentals of arithmetic should be taught to everybody. The utility of arithmetic in other fields of knowledge, its place as a recognized element of general culture, its wide applicability in daily affairs, its training in reasoning where the student knows he cannot bluff, the relative simplicity of its problems compared to problems of later life which the student may be expected to solve—these and other facts which we could discuss in more detail if it were necessary should insure for arithmetic a permanent place of importance in the curriculum of any elementary school worthy of being called an educational institution. I believe that we may count positively on this conclusion being

reached by all far-sighted educators, though we may expect to see a continual crop of dissenting innovators, who confuse change with progress and whose success in life seems to depend upon their noisy advocacy of iconoclastic views the soundness of which is a matter of secondary importance.

When the spirit of our times seems to require a new educational slogan at least once every decade, and when the assumptions in the slogans are followed out with all the recklessness with which, at the beginning of this paper, I have discussed the productivity of mathematicians in the distant future, we need not be surprised if a great diversity of recommendations lie ahead of us. Fortunately, there is a great deal of inertia, placidity, and common sense in the great body of teachers; changes will come slowly, and the wilder suggestions, though loudly proclaimed, will have been discarded by their advocates before any considerable number of teachers or schools have been injured by adopting them. I believe that we may look forward with reasonable assurance for the permanence of arithmetic in the elementary field.

The exact content of the mathematical program in the elementary school will, I hope, undergo a constant evolutionary process. The material which may be most advantageously presented at various intellectual levels, the manner in which it should be given, the type of illustrative material and applications which should be used, and the amount of time which should be spent on the various portions of the material, may well be under constant study by the teachers. As conditions in the lives of the students, the teachers, and the community change, alterations should be made in arithmetical instruction. Problems about *oxen* which seemed natural to me as a child would be out of place today; let us hope that problems about *work* should not for a similar reason be discarded in the future!

It is not my purpose to dilate on the problems of instruction in elementary arithmetic, but I do wish to raise one question—I wonder if at the present time a serious mistake is not being made by inadequate work in mental arithmetic. In my limited experience in this field of instruction, it has seemed to me that children are often times so worried over the difficulties of writing and of arranging their work that the arithmetic itself appears far more difficult than it should. The ideas when presented free from physical difficulties are easier to perceive, and arithmetic assumes the intellectual aspect that it merits.

I have found it surprisingly easy to teach a five-year-old to add two-sevenths and four-sevenths, to multiply two times six billion, and so on, before he is able to read or write any of the numbers. The child certainly gets the simpler ideas more easily and clearly through mental arithmetic than through written arithmetic.

Let us turn our attention for a few minutes to the place of mathematics in *secondary schools* in the future. What mathematics if any should be taught in our high schools?

A favorite way to answer such a question is to adopt a slogan, interpret it according to our interests, ignore most of the relevant features of the very complicated situation and come out with a simple solution. It reminds me again of the excessive productivity of mathematicians of the distant future.

I have not time today to go into details of the problem presented, nor have I a simple solution, but offer an idea or two for what they may be worth. We must ever bear in mind that our schools (in the cities at least) contain most of our population between the ages of 14 and 17.

A favorite slogan is that the school should be designed to "meet the needs of the individual." The interpretation depends on the speaker. To some speakers, "needs" refers to practical use in later life in earning a living. To me this is an absurdity—an absurd absurdity. For how do boys and girls earn a living? Examine the statistics on employment, then plan a four-year high school program that will be centered on meeting in this sense the needs of the individuals.

According to the Statistical Abstract of the United States, gainful occupations in 1930 were distributed as follows:

Manufacturing	29%	Clerical	8%
Agriculture	21%	Professional	7%
Trade	12%	Mining	2%
Domestic	10%	Public Service	2%
Transportation	8%	Forestry	1%

The number of *unemployed* was greater than the number of employed in any group except manufacturing and agriculture. Two-thirds of the employable were engaged in manufacturing or agriculture or were unemployed. Presumably, then, our high school program should be largely devoted to teaching our youth what they will use in a practical way in these occupations. Those of you who have visited a large modern manufacturing establishment and observed what the individual does to earn

his wages, may wonder how you are to spend four years teaching Johnny how to push a lever which neither you nor he has ever seen on a machine which has not yet been invented. What can we in Chicago do about teaching practical agriculture to boys and girls who have never been on a farm? How shall we teach boys and girls to earn a living by being unemployed? How can we find out which branch of trade Henry will actually engage in; and even if we find out that he will be a laborer in the stockyards or a retail dealer in groceries, which ones of us are going to spend four years teaching him how to do his job? Who among us will tell Mary that she is going to spend her life in domestic service, and then proceed to teach her (in four years) how to do the work in a way that will be approved by her future employer? The closer we examine the problem, the more obvious it becomes that of necessity a high school education for most persons will be devoted almost exclusively to things which they will *not* use directly in earning a living.

What then shall we do for high school students? I have no slogan to propose, but I wonder if it would not be well amongst other things to bring them into contact with some of the great achievements of the human race, to open the door for them to vistas which are the result of a million years of toil, of aspiration, and of thought, to broaden their outlook on this world and on life, to give them an inkling of the activities of the leaders of humanity if they do not themselves become leaders, and thus to enliven the hours *not* devoted to pushing a lever, or milking a cow, or selling groceries, or making beds, or carrying mail. I wonder if it is not true that a principal objective of the high school education for these students who are not likely to be intellectual leaders should be to prepare them for the leisure hours which are likely to constitute at least a half of their lives.

To my mind probably the most vital question with regard to the high school curriculum is, how can we maintain the desirable standards for that body of students who will become the intellectual leaders of the next generation? As I have previously intimated, that is a difficulty of the first magnitude because of the influx of weaker students into the high school in recent years. The administrators of secondary education bear a great responsibility at this point, one possibly fraught with disastrous consequences. There should be no doubt in the minds of the capable students as to what constitutes a most de-

sirable curriculum, and it should be made easy for a student to follow such a program—no, rather, it should be made difficult for him not to do so. And here it should be made emphatically clear that the pursuit of mathematics beyond elementary arithmetic is an absolute essential to future study in widespread fields.

With thoughts like these in mind, with the conviction that by all odds the most important function of the high school is to give the best possible training to the prospective leaders of the human race, I have no hesitation in saying that mathematics should have a most conspicuous place in the high school curriculum of the future, and that influences tending to relegate it to an inferior station are subversive of the best interests of the student body and of our civilization.

It is, however, a different question as to what the administrators of secondary education *will decide* to do by way of curriculum revision. Under a new slogan "Education for citizenship," interpreted to mean education by a study of civics, sociology, politics, and present day affairs, they may decide to turn their backs on the most characteristic feature of our own civilization, science, where definite and unquestioned advances have been made, and perhaps unwittingly make of our school system a seat of political propaganda which will lead to its becoming a politician's football. A glance at the school systems of Russia, Germany, and Italy, where "citizenship" is emphasized, shows this to be not only a *possible* but the *probable* outcome of emphasizing this slogan injudiciously. This movement appears to me, therefore, to be fraught with the most disastrous consequences.

Another familiar slogan, having its merits in a qualified way, is "The work must be interesting to the students." The trouble with this as with other slogans is in its interpretations. Does it mean that a subject is inherently unjustifiable if there are students who are not interested in it? If so, I fear that all of our education is unjustifiable. We have seen many a young Hercules baffled by the niceties of the logic of Plato and Euclid as found in our geometries; we have known many a social butterfly who was not thrilled by our modern version of Omar Khayyam's algebra. And we also have known innumerable boys and girls for whom the writing of a long theme is like the cleansing of the Augean stables, the pursuit of the elusive French language an abomination in the sight of the Lord, and the study of social science as fruitful as a search by a blind

man in a bottomless pit on a dark night for a black cat which wasn't there. In my opinion we should not be too concerned if some of our work appears difficult, and hence distasteful; on the contrary, we should be greatly concerned if it is *not* difficult, and worthy of serious effort, even though this render it unpopular.

And now as to the future, it is my opinion that with returning prosperity in our country will come greater stability, and that a new swing in educational theory will leave mathematics in a strong position in secondary education. It will become obvious that algebra and geometry are taught with greater satisfaction to students than are proposed substitutes, and responsible educators will remember that for students who go forward to study engineering and science (including physical, biological, and social science), the maximum of mathematical progress in high school is extremely important. It may be that the mathematics programs will be modified—for weaker students by substituting an easier subject for our present geometry, and for stronger students by making greater strides toward analytic geometry and the calculus.

Teaching

One element of the future of mathematics which I have not yet discussed is the teacher, in many ways the most vital of all. On the teachers rest largely the reputation of mathematics, and consequently its future welfare. I shall close my paper with a few remarks concerning teachers of mathematics, and teacher training.

In teaching, as in most of human affairs, much depends upon the individuals by whom the job is done. A great responsibility therefore rests upon us teachers individually.

Are we doing a good job? Are we doing the best that can be done? As to the first of these questions, I believe the answer should be, yes, with qualifications. As to the second, the answer is definitely, no, we are not doing the best that can be done.

As you all know, teachers in primary and secondary schools are bearing a heavy load, too heavy for them to be able to attain the teaching success of which they are capable. As you all know, in the *primary school*, a teacher handles customarily not only mathematics but a variety of other subjects from physical education to music and art, and is responsible for discipline and outside duties. The hours are long, and the classes

large. Conditions are far from ideal for the teaching of arithmetic to a heterogeneous mixture of wriggling children.

Moreover, it too frequently happens that a teacher in the elementary schools is herself weak in mathematics, she may not even be able to solve problems given to fourth or fifth grade students, much less explain them satisfactorily to children. With such a teacher, arithmetic receives a minimum of consideration; the pupils are likely to become discouraged and to share her more or less hostile attitude toward the subject, and there is a strong probability that they will develop a permanent feeling of dislike for it. Arithmetic to them may become a practically meaningless juggling of symbols.

In a subject like ours where there is a high degree of continuity of growth, the presence of a very weak mathematics teacher anywhere along the line to the high school may end more or less disastrously for the pupils. I am inclined to ascribe a great deal of importance to this situation, for I am convinced that when properly taught, arithmetic will present no very serious obstacles to most students, and that it will interest the vast majority of them. But it needs to be taught by teachers who know the subject and who have a large reserve of information and power on which to draw as occasion demands, and by teachers whose energies are not overtaxed by a multitude of other duties.

What improvements may we look for in the future? The improvements for which we should hope and pray are an adequate training in mathematics for all who teach mathematics, and a great reduction of the load placed on teachers. It should be possible under present and future conditions of general education and of unemployment to find a supply of adequately trained teachers to enlarge the present staffs and insure better teaching in all subjects. Some day, let us hope, instead of hiring unemployed persons to tear up good city streets, we shall use that money to improve instruction in the primary schools. When that day comes the instruction in elementary arithmetic will be greatly improved.

I have but a few moments left for discussion of teaching at levels above the primary schools. Accordingly, I shall only mention my conviction that teachers in junior colleges should have an extensive mathematical education quite comparable with the Ph.D. training common among university teachers. My remaining remarks will pertain to the secondary schools.

Here again a first necessity is a reduction of the load placed on teachers. The depression days have been met by adding to the teacher's duties until the burden has become almost unbearable. With improving economic conditions this situation will doubtless be greatly improved in the near future.

The problem of preparation of mathematics teachers for the secondary schools is an important one which merits careful consideration. I have strong hopes that the future will see great improvement, here, and that the general level of training will be materially raised. Too often in the past teachers have known but little mathematics beyond that taught in the secondary field, and even this but poorly. Obviously this deplorable situation needs rectifying, and with the great development in general education, I look for better days. Even in Teachers Colleges where mathematical training has been comparatively limited there is a recognition that more adequate training is needed, especially if some of the proposed alterations in the high school mathematics courses are to be brought about. It is obvious that an intelligent evolution of mathematical instruction cannot be accomplished by persons mathematically unintelligent or uneducated.

There is little doubt in my mind that before many years a master's degree in mathematics or its substantial equivalent will be a general requirement for teachers of mathematics in all of our better secondary schools. (This is already, I believe, the situation in California.) Many of the departments of mathematics in the universities are giving serious consideration to the question of the most appropriate work for such students. The teachers and prospective teachers are showing a lively interest in what is being done and in plans for the future. Though the program is in some respects only getting under way, there can be little doubt of its ultimate profound importance. We may look forward with confidence, I believe, to brighter days when the general standard of preparation of mathematics teachers is materially improved.

Summary

To summarize my outlook for the future of mathematics—(1) mathematical research will become more and more important to the world and will retain the respect of the community, (2) the school curriculum will be modified, but mathematics will retain an important place in it, and (3) the teachers

of the future will be more uniformly well prepared, their duties will be lightened, and there will be better mathematical instruction, insuring the perpetuity of a vigorous mathematical activity.

RADIO LESSONS IN ELEMENTARY SCIENCE

By Mary Melrose

Cleveland Public Schools, Cleveland, Ohio

Is the Radio One Way of Distributing Education?

Although we may not realize it, most of us learn certain things by listening to the radio. The news events of the day are digested for us in a few minutes. And whether we like it or not we become familiar with the latest in jazz. The radio has accomplished more perhaps than any other invention toward annihilating distances. It has in reality brought the world to our ears. Radio not only widens our horizon, but it multiplies our experiences.

So if the radio is a means for the dissemination of information why shouldn't we make use of it in our schools? Well, there are different points of view in answer to this question. There are those who think of the radio as a nuisance and that it has no place in the schoolroom. Another group anticipates that it will revolutionize education, while others conceive it to be an effective educational tool. Some of these must be mistaken and time will reveal who is correct in his thinking.

It is my belief that the radio can be a very effective tool in teaching, but because it is a new tool we do not know how to use it skillfully. Most of us are afraid of it and are timid at the microphone. But it seems the only way to learn how to use the radio as a tool in the teaching-learning process is to experiment with it. Any progress will be over that arduous road of trial and error.

How Shall We Use the Radio in the Classroom?

Educational broadcasts are, as a rule, of two types. The first type consists of interesting information given in the form of entertainment. Perhaps we might say it is information camouflaged, or sugar-coated, and frequently found in a dramatic setting. The second type of educational broadcast is a teaching situation. Therefore, the first problem the school must answer

is, "Should the broadcasts aim primarily to give general information in rather an interesting way, or should they aim to set up a teaching situation?" Naturally, the reaction of most school people is that the radio lesson should be a teaching procedure. However, the broadcasting stations, as a rule, favor the entertaining type. Many of them think the air should not be cluttered up with teaching. In the Cleveland Public Schools we believe the broadcast should set up teaching and learning conditions as a classroom situation.

What is the Size of the Radio Class?

There are approximately 7,000 sixth-grade pupils in the science radio class. The lessons are broadcast weekly over the 50,000 watt radio station WTAM to 5,758 sixth-grade pupils and 134 teachers in 105 Cleveland Public Schools. There are also five parochial schools and several schools in the suburbs and neighboring cities taking these lessons. The pupils in each school are organized into seven groups.

The classroom "stage" must be set for every radio lesson. Directions are sent to the teachers giving the outlines and drawings to be copied on the blackboard, and a list of the objective material that will be used by the pupils during the broadcast. The radio class meets just once a week. Thus the work of the entire week is projected for both teachers and pupils. Fifteen minutes is the broadcast period, and since the time allotment for science in the sixth grade is 120 minutes per week, the science teacher in each building is responsible for the other 105 minutes with the class.

What Techniques Can the Radio Teacher Use?

If a good classroom teacher does not talk 100% of the time, why should the radio teacher? If teaching be the purpose of the school broadcast, the lesson should contain not only informational material given in an interesting way, but it should also include pupil activity, pupil reaction, and pupil participation.

Several things that have been used in the science lessons to secure pupil activity are: dramatization, experimentation, observation, pupil reports, answering questions, carrying out directions. Better techniques to secure these will naturally be developed through further use of the radio. The radio teacher pauses 10, 15, 20, and sometimes 45 seconds, giving time for the pupils in the classroom to perform these various activities.

During the science broadcast pupils do not merely sit quietly listening. They are experimenting, examining and seeing many things that help to give real meaning to fundamental science concepts.

We have analyzed some of the radio lessons and have tabulated the type of each pupil reaction and the number of seconds utilized for each type. Five lessons that constituted a unit on a Study of the Sky had the following number of pupil reactions:

Questions	97
Carrying out directions	33
Observations	30
Suggested activities	8
Games	4
Dramatizations	3
Total	175

These 175 pupil reactions in the 5 lessons consumed 1,488 seconds or 24.6 minutes. As each lesson is 14 minutes in length (1 minute for the announcer), the total time for five lessons is 70 minutes. This shows that a little more than one-third of the time was devoted to pupil reaction.

Time for pupil participation during 3 lessons on non-flowering plants—yeast, mold and bacteria:

Questions	253 seconds
Experiments	226 seconds
Observation	185 seconds
Directions	92 seconds
Directions for the teacher	72 seconds
Total	828 seconds or 13.8 minutes

Total time of 3 lessons 42 minutes. Approximately one-third of radio time was devoted to pupil activity.

What are the Advantages of the Radio Lesson?

The radio is a good multiplier. It multiplies the time spent by one person on one lesson to many classrooms. It gives teachers many ideas of teaching techniques, and all phases of organizing and using objective materials. It keeps the teacher from spending too long a period on any one unit or any phase of the science course in which she is unusually interested. In fact, the radio becomes a long arm of supervision, as well as a distributor of precious packages of information.

Questionnaire

Some of the advantages listed by teachers:

1. Economizes time of pupil and teacher.
2. Teaches children to listen attentively, to concentrate, to follow directions promptly, to think quickly, to give concise answers, and to speak clearly.
3. Makes definite the scope of material to be covered in each science unit.
4. Presents models of carefully organized lessons and varied procedures.
5. Stimulates pupil interest.
6. Establishes cooperation of supervisor, teachers, and pupils in the teaching-learning process.
7. Speeds up learning. Maximum learning in minimum time.
8. Sets up a learning situation that proceeds without interruption.

What are the Limitations of a Radio Lesson?

1. The time pauses for pupils' discussion, answering questions, and carrying out directions, can not fit all pupils.
2. Children who are slow to act are at a disadvantage.
3. Radio reception is not always good.
4. The radio lesson cannot be geared to fit perfectly each of 7,000 pupils.

How Much Science Have the Pupils Learned?

To discover to what extent the pupils had learned the science subject matter given in the radio lessons, a test was administered at the end of each semester. As this is the third year we have been giving the science radio lessons, the results of four tests are as follows:

Date	*Grade*	*Perfect Score*	*Median*	*Lowest score made in city*
Jan. 1934	6B & 6A	50	41	20
May 1934	6B & 6A	33	28.3	14
Jan. 1935	5B & 5A	47	43	20
June 1935	5B & 5A	42	37.3	19

The problem of working out a test to be administered over the radio is one of the most difficult we encountered in the radio project. Our first test was not a very good one, but through it we found some techniques that could be used successfully and some to be avoided. The children are most enthusiastic over the radio tests. Although they were not easy, many made good scores, which gave both teachers and pupils a feeling of achievement.

Will the Radio Eliminate Teachers and Textbooks?

Never! The teacher is an integral part of our radio lessons. She does not stand quietly on the sidelines during the broadcast. Instead she is a busy person writing on the blackboard, calling on children to answer the radio teacher's questions, selecting pupils to perform the experiments and so on.

Neither will the radio ever take the place of books. Because radio lessons combine hearing, seeing and action, the child's

learning is not wholly dependent upon reading. We find, however, that the radio lessons stimulate and encourage children's reading for further information. So it seems the radio will stimulate the child's use of the textbook.

Teachers and books are essential in our plan of using the radio. Both of them however *will be influenced* by the radio.

What are Additional Possibilities?

Although our science lessons are far from perfect, we are gradually learning new radio techniques which make us realize more and more the possibilities of the radio. For example, in developing the science course of study it has been most helpful to find the reactions of thousands of children to certain units and parts of units. It would have taken years of experimentation in a few classrooms to have learned such definite indicators.

Yes, the radio offers an interesting set-up for experimentation, as the radio lesson has the controlled factors and each classroom of pupils and teacher are the variable ones.

To me, however, the most important use of the radio in the classroom is to lessen the burden of the teacher. Why should teaching remain such a hard and difficult task? Why shouldn't we use an invention that has the possibility of helping the teacher do efficient work with less labor in less time!

TRANSPLANTED HEARTS KEEP ON BEATING

Hearts of animals, transplanted to the bodies of other animals, kept on beating as long as their "adopted" bodies lived—a matter of three months or more.

Experiments with this unique outcome were reported before the meeting of the Zoological Society of America by Drs. W. H. Wright and H. H. Collins, of the University of Pittsburgh.

The animals were relatively lowly creatures—red-spotted newts, which are less-familiar cousins of frogs and salamanders. These animals will stand a good deal of surgery, apparently quite without embarrassment. Transplantations of legs and tails are quite an old story to them.

The hearts which Drs. Wright and Collins transplanted were taken from animals in their younger stages of development, and transplanted upon the body surfaces of adult animals. In some cases, the whole larval animal was thus grafted on an older individual.

In ten cases the hearts thus implanted continued to beat for more than 100 days, the maximum being 165 days. They stopped only when the "host" animal died, in every case. The blood vessels of an engrafted animal and its new heart frequently remained separate for a time, but finally united, so that both hearts were working on the same circulatory system. In all cases, the new hearts had a beat-rate different from the older hearts of the "host" bodies.

HUMAN GEOGRAPHY IN RELATION TO THE ZONATION OF VEGETATION IN THE SAN FRANCISCO MOUNTAIN REGION

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Unnoticed, but silently, incessantly, powerfully, and eternally the forces of nature are at work shaping the destinies of mankind. The plant environment is one of the natural factors that influence man's life profoundly. Through plants, the mineral foods of the earth are changed and conditioned so that the human body can utilize them. The type and character of vegetation is conditioned, in turn, by more basic factors, such as relief, soil, minerals, location, and climate.

The farther one gets out toward the pioneer fringe, the easier it is to see the way in which man responds to his natural environmental complex. In the pioneer stage man secures his living directly from nature. In such a simple society it is easy to see how he is influenced positively and negatively by his natural environment.

The San Francisco Mountain Region of northern Arizona portrays man out near the pioneer fringe and shows his adjustment to his natural environment, especially the vegetation factor. In this region the second native generation is now in control. Practically all of the older persons in this region entered it from other parts of our country. Most of the men over 40 years old and born in this community represent the first native generation. Although the influence and importance of the plant environment is to be emphasized other factors will not be neglected. The zonation of vegetation in the San Francisco Mountain Region is most striking. For number of zones, changes in short distances, and varieties of vegetation within small compass it has few equals. These mountains are located in north central Arizona about 60 miles southeast of the Grand Canyon of the Colorado. Approximately one-third of Arizona lying in the northeast portion of the state is a plateau, ranging in elevation from 5,000 to 8,000 feet. Rather, it is more correct to say that this area is made up of a series of plateaus, because there are different plateau levels which have received distinctive names. Such elevation in the latitude of northern Arizona, thirty-

five to thirty-seven degrees, gives to the region a temperate climate. In fact, on the higher portions of the plateau it gives a temperate climate of short summers and long winters with heavy snows.

The San Francisco Mountains rise approximately 5,000 feet above the 7,500 foot plateau at their base. They reach an elevation of 12,611 feet. These mountains are a group of volcanic peaks extruded through the sedimentary formations and forming a range of peaks with general northeast-southwest trend. Some of the minor peaks reach an elevation of 10,000 feet. San Francisco Peaks are the high points around a huge volcanic crater which opens to the plateau on the northeast side. Most of the plateaus of northeastern Arizona are made up of sedimentary rocks, limestone and sandstone being the chief types. Surrounding the mountains there are large extrusions of lava. Extensive fault lines are in evidence and in some places blocks of the plateaus have been raised several hundred or a thousand feet above the adjacent areas due to faulting.

The southwestern two-thirds of Arizona is mostly desert but where the prevailing westerly winds rise over the southwest face of the plateau covering the northeast portion of the state, sufficient rainfall occurs to give a fair growth of vegetation. On the 7,000 and 8,000 foot levels and on up toward the base of the mountains a medium to heavy growth of forests prevails. At Flagstaff at the south base of the San Francisco Peaks, with an elevation of almost 7,000 feet, the precipitation is over 20 inches. The precipitation decreases rapidly to the east and at a distance of 30 miles, and an elevation of a little under 5,000 feet, it has dropped to less than 10 inches. The variation in rainfall is an important factor in the zonation of vegetation. Such zonation occurs throughout the plateau and the San Francisco Mountains, but it is probably most clearly in evidence and studied most easily from the top of the highest peak southeastward toward the Little Colorado River. In this distance of about 30 miles one passes from rock-strewn vegetationless mountain summit through the Alpine and sub-Alpine zones, across the meadows and through the forests of firs and pines, and traverses the piñons and junipers out to the desert. The elevation with its influence upon rainfall, temperature, and length of the growing season is the chief factor which gives such great diversity of vegetation in so short a distance.

The Desert

The desert, as it is popularly called in this region, is not characterized by the same aridity as that in the southern part of Arizona and some other parts of southwestern United States. It has a heavier precipitation and the altitude of 4,500 to 5,000 feet gives its sufficient coolness so that more vegetation is found than is the case in the hotter portions of the southern part of the state. It is a semi-desert when compared to other desert regions of southwestern United States. This desert extends off to the northeast, and in the region to the east of the

Fig. 1. The Desert. The Last Remnant of Junipers.

Grand Canyon and northeast of the San Francisco Mountains forms the most striking part of the so-called Painted Desert. There is considerable diversity over the terrain of the desert caused largely by erosional features such as washes, canyons, arroyos, buttes, and mesas. The Painted Desert is a region in which the contrasts, diversity, and profusion of colors are especially beautiful. In the brilliant desert sunshine the reflection of light from the limestone cliffs and mesas is in marked contrast to the reds and pinks of the sandstones, the whole being interspersed with bare patches of gray desert surface. Over all hangs a blue-purple haze that changes in hues and brilliancy throughout the heat of the day, the variety and contrast of colors giving a scene of indescribable beauty. Van Dyke in his book "The Desert" gives a picturesque portrayal of the wonder-

ful view. So far as known, no artist has ever adequately portrayed it upon canvas.

While the richness of color characteristic of the Painted Desert does not prevail over the remainder of the desert surrounding the San Francisco Mountains, yet the blues, the purples, and the pinks of the haze that hangs over mountain and butte and fills the canyon depths give to this entire desert a distinctive beauty.

The desert vegetation is chiefly grass, sage, mesquite, and similar scrubby growth. These types of vegetation are especially adapted to desert conditions. The coarse grass is in scattered bunches with an extensive root system that enables it to gather the moisture from a comparatively large space about each bunch. During periods when moisture and temperature conditions are suitable it grows rapidly and then dies down during periods of deficient rainfall. The long thick roots of the sage and mesquite gather water for several feet about the plants. The small leaves of these plants with their thick epidermis and the cork-like bark of the stems and branches reduce loss of water by evaporation to a minimum. The hard, close-grained, brittle stems require a small amount of water and can endure long periods of drought. This type of vegetation covers the desert area and stretches for long distances on the lower elevations of the plateau. Almost the only economic opportunity the desert offers to man is a food supply for a small number of grazing animals. Consequently, it is uninhabited except for the few graziers who tend the herds of cattle and flocks of sheep that wander over the region feeding on the coarse bunch grass. Small hamlets have grown up along the railroads. These are found chiefly where cattle and sheep are brought to the railroad for shipment. Occasionally an isolated house used as headquarters for the herders may be found by a water hole or spring.

The Junipers and Piñons

Westward toward the mountains, and at a higher elevation with a consequent higher precipitation, a few stunted junipers and piñons are found. Because of the small amount of moisture available, these are shrub-like in appearance and size and are widely spaced. They have a height of but a few feet and in some cases their height is measured in inches. It is, indeed, surprising how rapidly this type of vegetation increases in height, size,

and thickness over short distances as a somewhat higher elevation is reached. In five to ten miles they attain tree-like proportions, having a height of twenty to thirty feet with a trunk diameter of a foot or two.

The belt of junipers and piñons at the east base of the mountains is five to ten miles in width and in places extends to the 7,000 foot contour. The surface in this belt is strewn with mantle rock from the underlying limestone, giving a whitish appearance to much of it. Over other areas the surface is covered with a thick mantle of scoriae, cinders, and ash from

FIG. 2. A Dense Growth of Junipers and Piñons.

the adjacent mountains. This is characteristically non-retentive of moisture. There is little doubt but that the rock and cinder formations have much influence upon the growth and distribution of trees in this area. Some of the trees have a diameter of a foot or more but most of them are only six to ten inches in diameter. Many such trees are one hundred years old or even more. Due to the deficiency of moisture, they have grown slowly and are stunted, dwarfed, and gnarled, the thick drooping branches reaching the ground in places. It is almost impossible for one to penetrate the denser portions of this thicket-like vegetation. However, in other places, wide expanses of bare earth or elongated winding galleries extend through the thicker growth.

As in the desert area adjoining, but few people live in this

belt. No agriculture is possible because of deficient rainfall and unfavorable soil and topographic conditions. The Indians gather quantities of piñon nuts which serve as an important item of food during the winter. Small amounts of these nuts are sold to the white people of the community. A few posts are cut from the trunks of the junipers and piñons and some fire-wood is hauled to scattered ranchers' homes. It is probably true that the larger ones could be made into cross ties for railroads, but so far as known no such use has been made of this timber. It is included in the San Francisco National Forest Reserve and is administered from the central headquarters at Flagstaff. Most of it is grazed, but there is little grass due to the thickness of tree growth and to the cinder or rock surface.

The Yellow Pine Forest

Along the higher margins of the juniper and piñon belt, where precipitation is somewhat heavier, a few scattered yellow pines appear. In lower basins where soil and moisture conditions are favorable, some of them reach a diameter of three feet. The transition from the piñon-juniper belt to the pine forests is quite abrupt. In some cases a mile spans the transition belt. On still higher ground with more abundant precipitation, the pines become more and more frequent and finally the junipers and piñons give way entirely to a growth of yellow pines. This type of forest begins at an elevation of about 7,000 feet on the eastern slope of the mountains and extends to an elevation of 8,500 to 9,500 feet. Above this elevation lower temperature and shorter growing season stop its growth. It extends higher on the warmer, sunny, southern slopes than on the other sides. The summit of Elden Mountain, 9,280 feet, is covered with yellow pines intermixed with fir.

Along the southwest border of the plateau, the yellow pine begins at an elevation of about 6,000 feet or almost 1,000 feet lower than on the eastern slope. Moisture conditions are probably chiefly responsible for this difference, although soil and rock formations may be factors. There is less cinder and ash along the southwest portion of the plateau than in the area to the east of the mountains. The southwesterly winds rising up the slope to the plateau become chilled and drop large quantities of moisture. To the east of the mountains the conditions are reversed. Here the southwest winds are descending, growing warmer, and absorbing moisture. Hence, a given elevation on

the southwest slope of the plateau receives more moisture than similar elevations on the slopes eastward from the San Francisco Mountains. The precipitation varies greatly from year to year. The average annual rainfall at Flagstaff is about 20 inches but as low as seven inches has been recorded.

The stand of trees in most of the yellow pine forest may be described as "fair." The mature trees are from three to four feet in diameter, although trees having a diameter of five feet are not uncommon. The trunks are smooth and taper upward with great regularity. The trees are rather widely spaced and

FIG. 3. A "fair" stand of yellow pine.

do not have a thick or extensive top growth. The open character of the forest permits a rich growth of grass over much of the forest floor. There is little undergrowth, so that one can see for several hundred yards across the forest. In depressions where moisture conditions are favorable, small patches of scrub oak are found.

It is in the yellow pine forest where most of the people in the San Francisco Mountain Region live. The forest gives rise to the chief industry of a large part of the region, that of lumbering. Several sawmills are located in this part of the forest. They are distributed along the Santa Fe railroad to facilitate shipment of the product.

The logs are brought to the main railroad artery by small temporary railroads constructed into the forest. The logs are

hauled to these railroads by means of log carts or skidders. Loading on to cars at the railroad is done almost entirely by mechanical loaders.

The individual mills have a capacity ranging from 30,000 to 100,000 board feet per day and employ from 50 to 150 men. These, together with the railroad men, the loggers, and miscellaneous employees, make the payroll of each mill from 100 to 300. It is the payrolls of the lumber industry which bring much of the prosperity to the region. Most of the unskilled labor employed in the mills is Mexican. These laborers live in rather poor temporary shacks, which remind one of the slum districts of our cities. The mills are thoroughly up-to-date, and use all types of modern machinery.

A large proportion of the lumber is converted into boxes. These are shipped, knocked down, to the vegetable and fruit regions of southwestern United States and to California and other Pacific States. A small quantity is exported some years. Heavy timber products such as mine props and cross ties are made in small quantities.

Most of the timber in this region is included in the National Forest Reserve. There are two exceptions to this, the railroad lands and the university and school lands. The forerunner of the present Santa Fe railroad was one of the land-grant railroads of the United States and it received large and valuable grants of timber. These are being cut rapidly and little attention is paid to conservation and a later crop of timber. Some of the school and university lands are being held at present and represent isolated square miles of timber surrounded by extensive cut-over lands.

The land held by the Federal Government and administered by the Bureau of Forestry is handled in an entirely satisfactory manner. Foresters mark all timber to be cut and provision is made for restocking or replanting. Some experiments in the piling and burning of brush and tops have been made, but in general, it has been found that such practice is too expensive. In later years the government has required only that tops be dragged away from standing timber to lessen the fire hazard.

As already stated, much of the forest is open and has a good growth of grass upon the forest floor. In fact, large areas of land with little or no timber are found distributed miscellaneously throughout the Pine Forest Belt. These areas range from five acres in size to one of 14,000 acres on the south slope of

Sitgreaves Peak. The explanation of these open lands, called parks locally, is not clear. The natural environment of soil, topography, precipitation, and temperature appear identical with those of adjacent forest lands. It may be due to destructive forest fires which killed the original timber, and to subsequent pasturage and occasional grass fires which have been sufficient to prevent the forest from reestablishing itself. These parks, together with the grass on the forest floor, make the region a valuable grazing land.

The government leases most of the land to sheep herders and cattlemen. The time of opening the range, the number of animals permitted per square mile, and similar matters are carefully adjusted to available pasture by the Forest Service. The income from the animal industries represents a second important source of wealth in the region. The animals are driven south off the plateau in the winter and use the plateau and mountain region as a summer range. Sheep herders often carry small tents with them and stay with the sheep from day to day, but the cattle are left largely to shift for themselves. Most of the ranges are now fenced. Some stock-men own four to five thousand head of cattle and 14,000 to 15,000 sheep. In some cases, both cattle and sheep are pastured on the same lands, the different animals eating different varieties of grass. Some of the stock-men have leased the same lands for so many years that the re-lease has become a matter of form. Their preference in such cases gives them rights very similar to those of ownership.

One of the best illustrations of transhumance to be found anywhere in the United States is in this region. The summer rains provide an abundance of good pasturage on the plateaus and mountains, but these same areas are covered with snows several feet deep during much of the winter. Hence, there has developed a marked seasonal migration into and from these pasture lands. The migration on to the plateau starts from southern Arizona in March and April. The graziers gradually work their flocks and herds to a higher elevation as the melting snows make good pasturage available. They reach the tree line in July. Hence, in midsummer animals cover the higher lands from the desert to near the mountain top. With the coming of severe frosts and light snows in September and October, the herds and flocks gradually descend the mountain slopes to the plateau. As lower temperatures prevail on the plateau, with consequently poor pasturage, they go to lower elevations and

most of the animals are driven off the plateau into the desert areas along the Little Colorado River or to southern Arizona by the end of the year. In some instances, sheep-men have lingered too long with their flocks on the higher elevations and heavy snow storms coming unseasonably early have caused wide destruction of sheep. Transhumance in this region differs from that as practiced in Switzerland in two respects. In the first place, it is confined wholly to the grazing industry, and secondly, families do not participate in the migration. The herdsmen are composed entirely of single men or men whose families stay in the adjacent cities while the owners, overseers, or hired men spend weeks or months with the herds and flocks upon the range.

The third important occupation of the people in the pine forest belt is agriculture. Most of the area is covered by thin rocky soils with the bed rock of limestone and basalt projecting through, so that plow agriculture is impossible. Erosion is very rapid on the plateau and mountains. Steep gradients, sparsity of vegetal covering in some areas, and the torrential type of rainfall combine to carry the soil away almost as fast as it is formed. So nearly are soil formation and removal balanced that insufficient soil has accumulated to cover all bed-rock extrusions. Along the narrow stream valleys which lead down from the mountains, the spring floods from the melting snows have deposited strips of rich alluvial soil. Large alluvial fans have been built up where mountain canyons debouch upon the flatter lands adjacent to the mountains. It is chiefly upon these two types of soils that agriculture is carried on.

It must be remembered that in this belt the rainfall averages about 20 inches per year with two rainy seasons. Heavy snows fall for two or three months beginning about Christmas and extending to March. The summer rainy season begins about the middle of July and lasts for approximately two months. It must also be remembered that the elevation of 7,000 feet gives to the region cold winters with a minimum temperature of 25° below zero Fahrenheit and cool and delightful summers with an absolute maximum temperature at Flagstaff of 99° Fahrenheit. Night temperatures may drop to 55°–60° Fahrenheit in midsummer. Such a physical environment of elevation, temperatures, length of growing seasons, and precipitation limit rather definitely the agricultural possibilities of the region. Warmth-loving crops like corn, and garden vegetables such as

tomatoes and cucumbers do not thrive under the climatic conditions which prevail. Barley and wheat are sowed as both winter and spring crops. Neither gives high yields. Oats sowed in the spring, while the soil is still saturated with moisture from the melting snows, sprout and start growth in May, and reach maturity during the summer rainy season. Most of the oats, however, are cut for hay to feed the farm animals and range livestock. The usual hay crops have not attained great importance. A money crop of some importance to the agriculturists is potatoes. Long distance from large markets tends to limit production of such bulky but cheap products. The potato probably originated in a climate very similar to this, and is, therefore, at home upon the cool plateau with its rather abundant summer rains.

Because of the restricted areas of soil suitable for agriculture, this industry will never become the dominant activity of the people. Properly developed, it will supply the necessary farm products to the people and animals of the region. There may be in some years, a surplus of a money crop such as potatoes.

Considerable space has been given to the human activities in the yellow pine belt. This is done because, as before stated, most of the people live in this belt and its economic importance far transcends all of the other belts combined. Ninety per cent of the forest area of the region and 99% of the merchantable timber is in this belt. The grazing interests are chiefly, and agricultural activities wholly, in the yellow pine belt.

Transition Zone

Above the yellow pine belt is a transition area. It lies in a comparatively narrow and irregular zone between the humid areas of the higher elevations and the sub-humid yellow pine belt. It ranges in elevation from 8,500 to 9,500 feet. In some places it dips considerably lower than this and in others rises to 10,000 feet. This belt is composed of a mixture of red fir, white fir, Arizona fir, scattered pines, and locally a rather heavy growth of aspens.

In some places there is a distinct belt of aspens extending for miles across the face of the mountains. There is some intermixture of pines and firs, but the aspens are the dominant tree. The aspens represent the primary restocking after extensive forest fires during Indian occupancy. After the first frosts of autumn have colored the leaves of the aspens, this belt of

yellow extends at an almost uniform elevation across the side of the mountain between the dark green of the fir forests above, and of the yellow pine below. Some of the aspens attain a diameter of from twelve to sixteen inches. An aspen forest unmixed with other trees is very beautiful. The long, white, straight stems taper upward with great uniformity. There are few branches below a height of twenty feet. The floor of the forest is clean and this sense of cleanliness is intensified by the smooth white trunks of the aspens.

FIG. 4. A mountain meadow.

Scattered across the face of the mountain in the transition zone are extensive meadows. These are not the Alpine meadows, or the "Alp", because they are several thousand feet below the tree line. Here, as in the yellow pine belt, it is difficult to account for the presence of the meadow areas. Dense forest rises in an abrupt wall on all sides of the meadow. In some cases long tongues or galleries of meadow extend like great lanes into the forest areas. Forest fires give the most plausible explanation of these meadows. Isolated decaying tree trunks in some of the meadows indicate that the areas have been forested. Such meadow tracts furnish excellent grazing grounds during the summer. The heavy precipitation promotes the growth of good grass. By July these hardy grasses have attained a height of one to two feet. The grass is of a coarse type but is readily eaten by cattle and sheep. One of the interesting sights in the

autumn is the camp fires of the graziers at night where they have established camp in the meadows. In some instances a number of flickering fires on the mountain side reveal the locations of the various camp sites to the observer at a lower elevation.

The Sub-Alpine Zone

Above the aspens and meadows which make up a large portion of the transition zone is the humid area of sub-Alpine vegetation. The lower part of this forest is made up chiefly of red, white, and Arizona fir. In some places the undergrowth is heavy and the forest floor is littered with needles and dead branches. This condition of the forest floor is in striking contrast with that of the yellow pine forest where the sub-humid climate permits only a scant undergrowth. The thick bed of needles facilitates the spread of forest fires and several extensive fires have occurred in this belt.

On the south slopes of the crater of the San Francisco Peaks, 18,000 acres have been almost wholly deforested. The fire occurred several decades ago, and most of the trees have now fallen. The forest was so dense that the prostrate trunks are criss-crossed in every direction making it almost impossible to ride a horse over much of the area. The logs are decaying, but the desert-like appearance of the area still remains. An attempt to reforest the tract by planting seed resulted largely in failure. Only a few sporadic evergreens show the results of the effort. It has been determined by experience that the successful method of reforestation in this belt is by the use of seedlings. Other extensive burned areas are found on the west slopes of the San Francisco Peaks and on Sitgreaves and Kendrick Peaks. Where not burned over, the fir forest has heavy timber, but it is difficult and expensive to log. The steep mountain slopes prevent the building of railroads into the area except by the use of switch-backs. The logs would then have to be dragged to the railroad by skidders. This is so expensive a procedure that lumber prices will have to attain a comparatively high level before it will be profitable to cut the timber off these areas.

Above the fir forest there is a narrow belt of Engleman spruce with some Arizona fir and bristle-cone pine intermixed. The trees of this belt for the most part do not grow to a large size. They attain a diameter of ten to sixteen inches and reach a height of fifty to seventy-five feet. They gradually dwindle into

stunted shrub growth at the tree line which is found at an elevation of 11,500 to 12,000 feet. The intensity of the struggle at the tree line is shown by the twisted, gnarled character of the trees and their creeping, prostrate forms. At the top of the highest peaks there is only about a month in which the night temperatures do not reach the freezing point. Such a short growing season is doubtless an important factor in determining the growth and character of the vegetation. The high wind velocity is inimical to tree growth in these high areas. The character of the trees already described is evidence of the result of these strong winds. The minimum winter temperatures at

FIG. 5. The tree line.

this elevation reach 40° to 45° below zero Fahrenheit and would preclude the growth of any but the more hardy trees. It would seem that the combination of adverse climatic factors is sufficient to prevent tree growth. Some observers believe that it is the soil factor rather than the climatic conditions which locate the tree line several hundred feet from the top of the mountain.

The only economic values of this upper zone are grass and water. No timber is cut at present and it is not probable that any will be used for a long time.

The water supply furnished by this zone is its greatest asset. During the spring and early summer the heavy snows melt and the water rushes down the mountain canyons and out on to the more nearly level portions of the adjacent plateaus. Much

of it is impounded in tanks and is thus preserved by the stockmen for a water supply during the summer. Practically none of it is used for irrigation directly. During the flood stages many of the small streams overflow the adjacent flood plains and saturate them with water. This overflow keeps such lands moist until the summer rains of July begin. We thus have, on a small scale, an example of early Nilotic agriculture. No attempt has been made to store the water for irrigation purposes. It is not probable that irrigation works will be built because the water supplied by the floods and the moisture already in the soil from the melting snows of winter usually is sufficient to tide the crops over until the summer rains of July commence.

Much of the melting snows of this zone sinks immediately into the rocky or cinder surface of the mountain side and emerges as springs near the base of the mountains. These springs are of inestimable value to the grazing industry. They serve as dependable supplies of water during the entire summer. Two of the chief cities of the region, Flagstaff and Williams, secure their municipal water supply from these springs. Flagstaff, with the assistance of the Santa Fe railroad which uses part of the water, built a pipe line from Smith Springs on the northeast side of the San Francisco Mountains around the base of the mountains and impounds the water in two reservoirs located some five miles northwest of the city. The two reservoirs have combined capacity of 100 million gallons. Not all of the water at Smith Springs comes from underground sources. Much of it comes directly from surface streams supplied by melting snows inside the crater. The snows in the heavy forests of this belt melt much more slowly than those in the open spaces. The forests thus help to conserve the water by retarding the rate of the melting of the snows. The water supply is being carefully utilized and can not be greatly augmented.

Williams secures its water supply from a similar spring on the side of Bill Williams Mountain. Various propositions have been suggested for piping water from the vicinity of these mountains to the "Grand" Canyon, but nothing has yet been done. The cost of such construction would be so great and the demand for water at the Canyon so limited that it probably would not be a profitable venture. With an increased demand for water at the Canyon it may be profitable at some future time to construct such works.

Due emphasis should be given to the importance of water

supply. Water in this region represents very definite values. During the dry seasons of late spring and early summer and of late fall and early winter, city communities would find it impossible to exist were it not for the water available from the streams and springs in and about the mountains.

FIG. 6. Above the tree line.

The area 500 to 1,000 feet above the tree line is composed of huge boulders and volcanic materials. There is very little fine soil. There are no extensive Alpine meadows and only small isolated patches of grass are found. This barren desolate area has no economic value save for its contribution to the water supply.

PLANT SPORES SURVIVE TRIP TO STRATOSPHERE

Surviving conditions where man would die, tiny spores of important plant diseases are growing in a laboratory of the Department of Agriculture here after journeying nearly 13 and 3/4 miles into the stratosphere with the balloon Explorer II.

Discovery that spores can still live after being sent to an altitude of 72,395 feet is the first scientific conclusion from the recent ascension sponsored by the National Geographic Society and the U. S. Army Air Corps.

Here's what the spores carried aloft by Capts. Albert Stevens and Orvil Anderson to a new world's record had to withstand:

1. Temperatures lower than 65 degrees below zero Fahrenheit.
2. Such a low atmospheric pressure that man could not live in it.
3. Ultraviolet rays from the sun which never reach the surface of the earth and which are capable of killing some forms of life.
4. Ozone.
5. Extreme dryness.

—*Science Service*

DECIBELS AND NOISE

By F. R. Watson
University of Illinois, Urbana, Illinois

What would happen if all automobile horns were abolished? There may be some difference of opinion about how much safer driving would become, but there is no doubt about the reduction of noise. Another question concerning the automobile is this: Would you remove the tires from the wheels and drive down the street on the rims? Certainly not, you answer, it would make a terrible racket and would wear the car out in a short time. But the street cars do this all the time!

These questions about the automobile are not altogether hypothetical; the sounding of auto horns is prohibited in Rome, and is minimized in London. Travelers report that automobile driving is much quieter and safer for pedestrians and drivers in these cities than in Paris, where automobile horn sounds are incessant. Also rubber tired buses are becoming more numerous, and are replacing the noisy street car. Vigorous movements are in progress in many cities to reduce noise, most of which is unnecessary and is a constant irritation and a potential danger to the physical welfare and comfort of the people.

Scientific attacks supporting this movement revealed long ago the necessity for some unit which would give numerical values of noise, with possibility of measurement of any reduction of the evil. Certain legal aspects of the problem called for definite numerical values to determine when noise was harmful. Such a unit has been developed and is called the decibel.

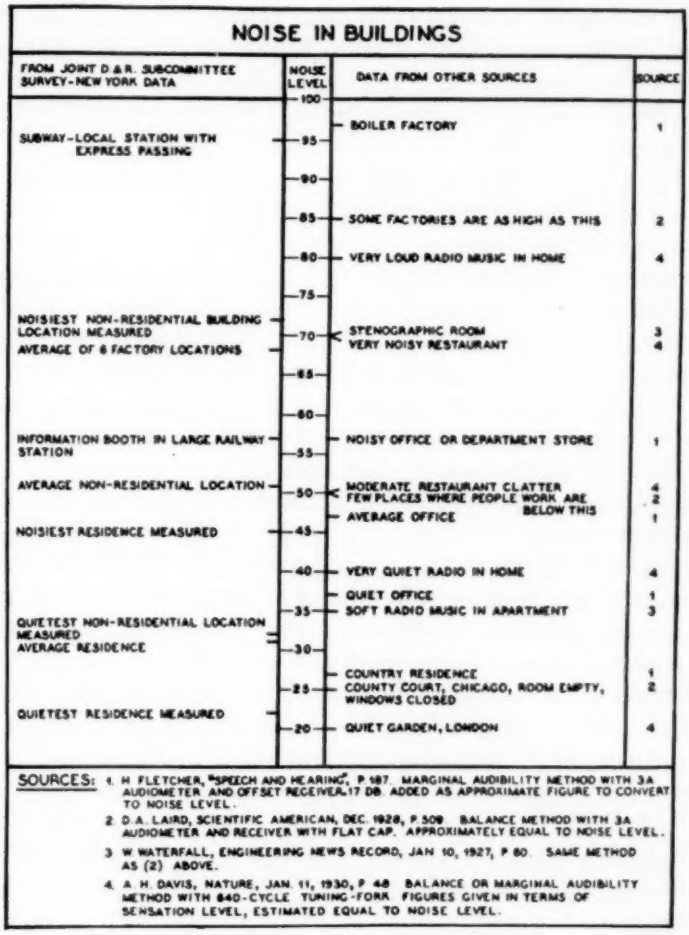
A first conception of the decibel may be obtained by comparing it with temperature. One hundred decibels of noise is about as uncomfortable as 100 degrees of temperature; also, a reduction of the noise to 70 decibels is about as much relief as a drop in temperature to 70 degrees. The analogy cannot be pushed further, however, because zero decibels of noise is not uncomfortable at all; it means that the noise can no longer be heard.

The decibel is accurately defined by a mathematical equation, and readers not familiar with logarithms had better skip this paragraph. The difference, L, between two sounds in decibels is defined to be:

$$L \text{ (decibels)} = 10 \log. (I_1 \div I_2)$$

where I_1 and I_2 are the intensities, or power, of the sounds. For

example, the decibel difference between the sound of 10 violins and one violin is $L = 10 \log (10 \div 1) = 10$ decibels; between 100 violins and 1 violin, the difference is: $L = 10 \log (100 \div 1) = 20$ decibels, etc. Fig. 1 exhibits various noises on a decibel scale as


NOISE IN BUILDINGS
FROM JOINT D & R. SUBCOMMITTEE SURVEY-NEW YORK DATA
NOISE LEVEL
DATA FROM OTHER SOURCES
SOURCE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
SUBWAY-LOCAL STATION WITH EXPRESS PASSING
NOISIEST NON-RESIDENTIAL BUILDING LOCATION MEASURED
AVERAGE OF 6 FACTORY LOCATIONS
INFORMATION BOOTH IN LARGE RAILWAY STATION
AVERAGE NON-RESIDENTIAL LOCATION
NOISIEST RESIDENCE MEASURED
QUIETEST NON-RESIDENTIAL LOCATION MEASURED
AVERAGE RESIDENCE
QUIETEST RESIDENCE MEASURED
BOILER FACTORY 1
SOME FACTORIES ARE AS HIGH AS THIS 2
VERY LOUD RADIO MUSIC IN HOME 4
STENOGRAPHIC ROOM 3
VERY NOISY RESTAURANT 4
NOISY OFFICE OR DEPARTMENT STORE 1
MODERATE RESTAURANT CLATTER 4
FEW PLACES WHERE PEOPLE WORK ARE BELOW THIS 2
AVERAGE OFFICE 1
VERY QUIET RADIO IN HOME 4
QUIET OFFICE 1
SOFT RADIO MUSIC IN APARTMENT 3
COUNTRY RESIDENCE 1
COUNTY COURT, CHICAGO, ROOM EMPTY, WINDOWS CLOSED 2
QUIET GARDEN, LONDON 4
SOURCES:
1. H. FLETCHER, "SPEECH AND HEARING", P. 187. MARGINAL AUDIBILITY METHOD WITH 3A AUDIOMETER AND OFFSET RECEIVER-17 DB. ADDED AS APPROXIMATE FIGURE TO CONVERT TO NOISE LEVEL.
2. D.A. LAIRD, SCIENTIFIC AMERICAN, DEC. 1928, P. 509. BALANCE METHOD WITH 3A AUDIOMETER AND RECEIVER WITH FLAT CAP. APPROXIMATELY EQUAL TO NOISE LEVEL.
3. W. WATERFALL, ENGINEERING NEWS RECORD, JAN. 10, 1927, P. 80. SAME METHOD AS (2) ABOVE.
4. A. H. DAVIS, NATURE, JAN. 11, 1930, P. 48. BALANCE OR MARGINAL AUDIBILITY METHOD WITH 840-CYCLE TUNING-FORK. FIGURES GIVEN IN TERMS OF SENSATION LEVEL, ESTIMATED EQUAL TO NOISE LEVEL.

DECIBEL SCALE OF NOISE LEVELS.
(Tucker, Journ. Acous. Soc., Vol. 2, page 63, July, 1930.)

they appear to the ear. If, on this scale, 1 violin has a level of 35 decibels, then 10 violins will have 45 decibels, 100 violins will have 55 decibels, etc. Noises below 25 decibels are so weak as to be heard only with difficulty. Above 30 decibels, noises become more noticeable, and those above 50 decibels are generally

regarded as uncomfortable. Above 100 decibels, the disturbance becomes too painful for the ear to stand.

Among the various disturbing noises, those encountered in rooms are a matter of concern because they affect the comfort of the large number of people in offices, schools, hospitals and other buildings. The most common sources of noise are machines, radios, musical instruments, and people. The staccato sounds of typewriters and calculating machines are especially disturbing; even the musical hum of a motor or radio becomes unbearable if continued for some time.

The reduction of these sounds is brought about by certain devices. Machines can be designed so as to make less noise, as for example the "noiseless" typewriter. Calculating machines will doubtless be made more quiet in the future, but the best possibility now to reduce the noise is to cover them with a case of glass, or other solid, with an inside lining of sound-absorbing material; or else to house a number of the machines in a small room with an ample amount of absorbing material. The reduction of noise is economical—the efficiency of employees is increased, and quiet machines last longer.

In school rooms, the problem of noise is different. A reverberant room sets up conditions that make it difficult for pupil and teacher to understand each other, except with effort. The sound of each spoken word is reflected many times from wall to wall and takes some time to die out. In the meantime, other words are spoken, the sounds of which mix with the preceding sounds and make a confusion for listeners. The correction for the difficulty lies in covering the highly reflecting walls and ceiling with special materials that absorb sounds and make them die out faster. Pupils and teachers in quiet rooms are less tired and irritable than those in reverberant rooms. Placing absorbing materials on corridor ceilings and walls is especially helpful, because pupils are usually more noisy here than in the school rooms.*

The preceding discussion indicates some of the possibilities for reducing noise. Some progress is being made, and more may be expected. The Acoustical Society of America, The American Standards Association, The Engineering Safety Council, and other organizations have all voiced protests against unnecessary

* Information about correction of acoustics of rooms can be obtained from the Acoustical Materials Association, 919 N. Michigan Avenue, Chicago, an organization of the principal companies that make acoustical corrections according to the best scientific practice.

noise, and have appointed committees to coöperate with civic authorities in programs of reduction of noises. Teachers can help the movement by instructing pupils in the evil effects of noise.

A NEW TREND IN HIGH SCHOOL CHEMISTRY

By Clyde E. Riley
Westborough, Massachusetts

There are always in the last years of high school a small group of students who would like to take chemistry; yet because they think it is too hard or that they might not be able to pass the course fail to elect it. With this group in mind and with the approval of the Administration, I performed the following experiment.

The usual procedure was to have two classes of chemistry, dividing them into as equal groups as possible and giving them a course strong enough for honor pupils to use it as a credit for college entrance. The new procedure was to have two classes just the same but designating one as a college preparatory course and the other a general course in chemistry without credit for college entrance. The registration in the college class was thirty; in the general class it was twenty-eight.

Several things were necessary to prepare for a general course. Some of the important ones which I will briefly discuss were:

(a) Revising certain aims
(b) Choosing a new text
(c) Adjusting the course to the new type of student

Certain new aims were necessary. Two definite ones stand out—namely, the elimination of equations and the solving of problems for the first half year at least. During the last half year very easy and yet important equations were discussed and mastered. Also simple problems were handled slowly but thoroughly. Definite attempts were made to arouse interest and sustain it by laboratory work, class demonstrations and outside reports. There was apparently no haste and mastery of the present material was stressed.

By far the greatest task was choosing the text. As many texts as were available were evaluated as to contents, binding, illustrations, organization, adaptability, etc., and strange as it may seem, *Chemistry in Everyday Life*, by Charles B. Cook (revised

1923) was adopted. It fitted best the type of course I had in mind.

At the end of the year both classes were given Powers' test in general chemistry. Before the results are given a few facts about the classes should be stated:

General Chemistry class	Highest I.Q.	121
	Lowest I.Q.	98
	Median I.Q.	111.6
College class	Highest I.Q.	131
	Lowest I.Q.	105
	Median I.Q.	118.1

The results of the tests were as follows:

General class	—Part I —17	on general information
	Part II— 7.8	on equations and problems
College class	—Part I —18	
	Part II—19	
Median for test	—Part I —18	
	Part II—19	

From the foregoing data it is easily observed that the college preparatory class compared exactly with the test medians and the general class was very close to the median in part I but was very low in part II. This was as expected.

This readjustment of courses has provided for the average pupil a more practical course, given with less technical work and more interest, yet maintaining satisfactory standards. The college class is free from a group of slow students and is able to advance more rapidly.

[Editorial Note.—Might not some of the rest of us accomplish more with our students if we too would "eliminate" much of the subject matter we try, in vain, to "cover" and handle "simple problems slowly but thoroughly" while stressing "mastery of the present material"?—Frank B. Wade.]

SOVIET COAL MINES IN THE ARCTIC

The Spitzbergen coalfields leased by the U.S.S.R. from Norway, increased considerably their output of coal during 1933–34, and have this year fully met all the fuel requirements of the Soviet Arctic shipping. The mines are continuing to develop their work. The annual plan of coal output was accomplished by nearly 90 per cent by Oct. 1.

A DISCUSSION OF SEARS, ROEBUCK AND COMPANY'S THIRTEEN PERIOD CALENDAR

C. L. SCHENK

Sears, Roebuck and Co., Chicago, Illinois

On January 1st, 1930, Sears, Roebuck and Company announced that it would conduct its business on the basis of a 13-period year instead of conducting it according to a 12-month calendar. It is believed that this company is the first large mercantile concern to adapt the 13-period calendar plan to its business.

This idea is not entirely new. The 13-period calendar plan was originally proposed by an Italian Catholic priest in 1835 and the present adaption of that idea was made by Moses B. Cotsworth, a Canadian, 30 years ago. Regardless of the age of the idea, scores of inquiries have been received by Sears, Roebuck and Company as to how the 13-period plan is working out for its business.

The calendar, it has been pointed out, is a man-made device for keeping track of time. Julius Caesar made a calendar for himself; then Augustus Caesar came along and changed that a little. Both were changes from the old Roman Lunar calendar. The present calendar used in the United States was made in 1582 but was not adopted by England and her colonies until 1752. Pope Gregory gave us the present calendar under which the United States and a large part of the world operates today but there are also in existence other and different calendars which control the lives of upwards of one billion forty-five millions of people. India alone has 17 different calendars in that country.

Sears, Roebuck and Company entered upon the 13-period calendar plan in order to be able to make more definite and accurate comparisons than it is possible to make when operating on the 12-month calendar.

In commencing this discussion, it may be well to consider that things are good or bad relatively, that is, by comparison with a standard or with conditions before or subsequent to an examination of facts or experience.

In the case of the thirteen period business calendar, we have to consider the advantage or disadvantage by comparison primarily with the other alternative which is the more generally accepted twelve months calendar year basis.

We feel in Sears, Roebuck and Company that the thirteen period plan as applied to our business has been both a convenience and a success and has many advantages over the regular calendar year.

The plan does not require reforming the calendar generally, although some advantages not now possible would occur if all business adopted a similar calendar for business purposes. On the other hand, we believe that none of the suggestions for legal calendar simplification provide important improvement from the standpoint of business as related to comparability of results and statistics over our adaption of the idea to the internal workings of our own business.

The calendar used by Sears, Roebuck and Company for the conduct of its own business will always begin on January 2nd for the first period and the first period will end on January 29th. With the exception of leap year, there will always be four Mondays, four Tuesdays, four Wednesdays, four Thursdays, four Fridays, four Saturdays and four Sundays in each Sears, Roebuck and Company period. January 2nd will be the first day of the first period no matter on what day of the week January 2nd falls.

Not all firms following the 13-period plan designate January 2nd as the first day of the first period and the fact that the Sears, Roebuck and Company 13-period calendar always begins on January 2nd and always ends on January 29th is one of the outstanding features of this 13-period plan of the company. This plan will make possible very accurate comparisons of the various periods in the various years.

It seems unnecessary to dwell upon the discrepancies and difficulties involved in trying to compare results and statistics of business under the twelve months calendar. The report of the National Committee on Calendar Simplification, issued in 1929, shows by a series of graphic charts, many of the discrepancies caused by

1. Difference in number of days in the respective calendar months
2. Difference in number of Saturdays and Sundays by months
3. Consequent difference in number of working days in various months compared with each other and with the same months of previous and subsequent years.

Our company has always had Sales, Orders and various other data by days, weeks and months, and progressively accumula-

tive by Season and for the Year. Long before the adoption of the thirteen period calendar, we found that bi-weekly and four-weekly payroll records and reports were necessary to proper understanding and control of payroll results.

We started out to overcome the natural disadvantage of the twelve months calendar and have regular four-weekly accounting periods as far as practicable within the limits of the calendar year.

We promptly discovered that we could not stick to conventional weeks always ending on Saturday and concluded that it is not necessary. Weekly pay days are adjusted each year to the difference in the day ending the week.

January 2nd was fixed as the first day of the year and January 29th as the last day of the first accounting period, all subsequent accounting period to end at four-weekly intervals.

This established thirteen equal four-weekly periods ending December 31st and left over January 1st, a non-business day. (This changes only in leap years.) Since it is the policy of our company to pay for National Holidays, January 1st had to be included so we have placed the Payroll Expense for this day into the Accounting period ending December 31st. Except for Payroll, there is no practical necessity for any other consideration. When January 1st falls on Sunday, of course, the day is celebrated on Monday, the first day of the next accounting period.

Leap Year creates a disturbance every four years in the plan for thirteen equal four-weekly periods. The extra day comes, of course, in the period beginning February 27th and ending March 26th. We have left it there so as not to disturb any of the period ending dates as planned.

In 1932, March 26th was Saturday and except for February 29th coming into the picture, it would have been Friday, so the disturbance amounted to an extra Saturday in the period.

Saturday is the smallest day of the week in the Mail Order and in addition, it makes practically no difference because the Mail Order now operates on a five-day week basis. In the Retail, however, Saturday is the biggest day in the week, which makes important difference in comparisons which have to be taken into consideration by all concerned.

Ordinarily the ending day of the weeks and periods for the fixed dates under the plan will be one day away each succeeding year, except in leap years, when after the extra day in February

there is two days difference in the days for the balance of the year.

Every National Holiday falls in the same period every year. The disturbance on account of Labor Day and Thanksgiving falling a few days sooner or later in different years is similar to conditions under the twelve months calendar.

Again referring to the report of the National Committee on Calendar Simplification; this shows in thirty-one years (1928–1958) that Easter day wanders from March 22nd to April 25th, and during all that time comes

Twice in our period ending March 26th
Twenty-eight times in our period ending April 23rd
Once in our period ending May 21st

Under the twelve months calendar basis the division is

Six times in March
Twenty-five times in April

Neither method is a solution to the Easter disturbance in comparison and statistics because the amount of business in the period or months affected is influenced by the factor of whether the day comes early or late in the period or month and in relation to the Spring (weather) Season. An allowance for the position of Easter must always be made in reaching conclusions based on any comparison of statistics covering certain weeks preceding and subsequent to the day.

If Easter day were fixed, this disturbance except for weather would be avoided under either calendar.

In 1932 we decided to go from a calendar year to a fiscal year commencing January 30th and ending the following January 29th, comprising thirteen accounting periods otherwise exactly the same as described.

In five years, comprising sixty-five accounting periods, except for the added one day payroll in the four periods ending December 31st, only one other period suffered disturbance and variation compared with the ideal.

This makes it possible to check and compare results and statistics as between periods in the same year and the same periods in previous and subsequent years after a fashion that is obviously not possible under the twelve month plan.

There is a common factor or basis for such comparison which is the fact that practically every accounting period is four weeks, twenty-eight days, comprising four of every day in the week, as against all of the variations occurring under the monthly basis.

This comparability is not confined to any particular class of statistics. Our experience indicates that it may be extended to all classes that decision places into the category of data to be compiled daily, weekly or by four-weekly periods as preferable to the monthly basis.

In budgeting and budget control (particularly in a business like ours where merchandise and operating budgets are prepared and submitted by men in all the various stores) the thirteen period basis has made possible much in the way of improvement and refinement, principally because of the greater ease by which it is possible to distinguish trends and make comparisons.

The 13-period calendar presents some difficulties, it is frankly admitted, but the advantages far outweigh the objectionable features of the calendar in the minds of those who have given it considerable study.

Prior to adoption, it was considered that thirteen closings would be more work and more expense than twelve, not so much from the standpoint of the additional cut-off as from the fact that it required the labor and expense of producing one additional period's statement each year for all of our stores, which insofar as that particular part of our activities is concerned, all other things being equal, would represent about an 8 per cent increase in expense.

Altogether, however, we have concluded from our experience that this has proved to be more theoretical than factual. Conditions during the years since adopting the new calendar make it extremely difficult to say definitely there has not been some additional cost, but which we are certain must have been extremely small, because of known offsetting factors to compensate for this.

We have saved all the accrual of payrolls to a monthly basis and the consequent reconcilement with the four-weekly payroll reports. Salaried employes formerly paid by monthly check now receive thirteen checks a year, each check one-thirteenth of the total yearly amount.

We have been able to consolidate and combine various statements covering every four weeks of merchandising and operating and increase manyfold the usefulness of these reports as means of current control and correction.

This alone has so clarified and simplified the problem of presenting the facts relating to operations and merchandising that we have saved much in the way of special analyses and reports

formerly needed to supplement and explain the statements of monthly results.

Obviously it has not been practical in most cases for outside contacts to conform with our calendar or for us to require it. We have encountered no important complications because others go by the twelve months calendar.

Bills for monthly services, of course, must be adjusted to the period basis by deferring the amounts exceeding the portions chargeable for four weeks.

Rents, fixed charges and similar items on a monthly and yearly basis are easily converted to the period basis by determining the annual figures and dividing by thirteen. Some adjusting is necessary in the case of rents determined by a percentage of monthly Sales.

In the case of bills payable, we handle under a voucher system which treats every invoice as a completed transaction. Accounts payable must be determined at the end of every period by an inventory of unpaid items holding. That requires one more inventory than under the twelve months calendar.

The principal exception to this, and most difficult one to handle, is the case of Retail Store advertising bills for space, which ordinarily are rendered by conventional weeks or monthly by newspapers, periodicals, etc. We naturally must be in position to establish actual advertising figures according to our own periods.

Most of our receivables are monthly payment (installment) accounts. We know at the end of every day the outstanding balance. No change in conventional billing or collection procedure is required by the thirteen period calendar.

In the case of bank statements, we have always received daily statements of the large accounts which are constantly in process of reconcilement, and in most of the other accounts where any important job of reconcilement is required, we are getting statements on the basis of our period closing.

So far as the Income Tax is concerned, the problem is no different than under the twelve month calendar.

When it comes to making comparison with competitors, we naturally have to adjust our figures to the basis that makes them comparable with whatever period of time is covered by the information available to us. This is relatively unimportant by comparison with the benefits accruing to us with respect to our own operations.

Generally we supply information to trade associations on a periodic basis.

Where the government asks for information on a monthly basis, we furnish the periodic figures together with figures showing adjustment to a monthly basis.

Divisions into quarterly and semi-annual periods in a general merchandise business such as ours, are relatively of little value so far as attempts at comparison of different quarters of the same year contribute anything important from the standpoint of control of operations. We do keep all our figures cumulative as we go along, for comparison with other years, but the weekly figures and periodic statements are the important data for purpose of correction and control.

Our principal financial statement, of course, is issued annually, as soon after the completion of the end of year inventory as is practical to complete the figures. We also take a semiannual inventory and obtain Spring Season financial and operating results for the first six accounting periods of the year, that is, for the period commencing January 30th and ending July 16th.

The fact that by comparison there is left seven accounting periods in the subsequent Fall Season to complete the balance of the year, has proved to be no handicap and of little importance in our schemes of operations.

Much of our business is Seasonal in its character and there are so many differences in type and volume of business and its distribution by departments and commodities in the Fall by comparison with the Spring, the practically no important purpose was ever served by attempts at comparison of results for and entire Fall Season against the Spring Season. The important comparisons are of the respective Seasons against other years, set up on a comparable basis.

When it came to introducing the thirteen period calendar, of course, it was considered advisable and necessary not to forego entirely comparisons with the previous year. However, our knowledge of the significance of relationship existing between the number of days in a period and number of days in a month with relation to certain items and the basis of ratios by which various other items of information comprising our records and statements have been judged over a long period of years, enabled us to adjust our records for the previous year from the twelve month calendar basis to the thirteen period basis plenty close enough for all practical purposes as a check upon the re-

sults of the first year of operations under the new calendar.

Of course since that time there has been no problem since all figures have been on a more comparable basis than they were before.

SEARS, ROEBUCK AND CO.

The 13 Periods for the Fiscal Year of 1934

1ST PERIOD	T	W	T	F	S	SUNDAY	M
January	*30*	*31*	F-1	2	3		5
February	6	7	8	9	10		12
February	13	14	15	16	17		19
February	20	21	22	23	24		26
2ND PERIOD							
February	*27*	*28*	M-1	2	3		5
March	6	7	8	9	10		12
March	13	14	15	16	17		19
March	20	21	22	23	24		26
3RD PERIOD							
March	*27*	*28*	*29*	*30*	*31*		A-2
April	3	4	5	6	7		9
April	10	11	12	13	14		16
April	17	18	19	20	21		23
4TH PERIOD							
April	*24*	*25*	*26*	*27*	*28*		*30*
May	1	2	3	4	5		7
May	8	9	10	11	12		14
May	15	16	17	18	19		21
5TH PERIOD							
May	*22*	*23*	*24*	*25*	*26*		*28*
May	*29*	*30*	*31*	J-1	2		4
June	5	6	7	8	9		11
June	12	13	14	15	16		18
6TH PERIOD							
June	*19*	*20*	*21*	*22*	*23*		*25*
June	*26*	*27*	*28*	*29*	*30*		J-2
July	3	4	5	6	7		9
July	10	11	12	13	14		16

7TH PERIOD	T	W	T	F	S	SUNDAY	M
July	17	18	19	20	21		23
July	24	25	26	27	28		30
July	31	*A-1*	*2*	*3*	*4*		*6*
August	*7*	*8*	*9*	*10*	*11*		*13*
8TH PERIOD							
August	14	15	16	17	18		20
August	21	22	23	24	25		27
August	28	29	30	31	*S-1*		*3*
September	*4*	*5*	*6*	*7*	*8*		*10*
9TH PERIOD							
September	11	12	13	14	15		17
September	18	19	20	21	22		24
September	25	26	27	28	29		*O-1*
October	*2*	*3*	*4*	*5*	*6*		*8*
10TH PERIOD							
October	9	10	11	12	13		15
October	16	17	18	19	20		22
October	23	24	25	26	27		29
October	30	31	*N-1*	*2*	*3*		*5*
11TH PERIOD							
November	*6*	7	8	9	10		12
November	13	14	15	16	17		19
November	20	21	22	23	24		26
November	27	28	29	30	*D-1*		*3*
12TH PERIOD							
December	*4*	*5*	*6*	7	8		10
December	11	12	13	14	15		17
December	18	19	20	21	22		24
December	25	26	27	28	29		31

13TH PERIOD	W	T	F	S	SUNDAY	M	T
January 1935	2	3	4	5		7	8
January	9	10	11	12		14	15
January	16	17	18	19		21	22
January	23	24	25	26		28	29

It is apparent from this discussion that the problem relating to the accumulation and preparation of accounting and statistical data of a business are not solved by the introduction of a new calendar. There are still plenty of problems. Many of them can be solved by the adoption of a universal business calendar such as ours, nevertheless I do not believe that a com-

pletely ideal situation with respect to business statistics is ever obtainable. Business is in a constant state of flux and change which brings new conditions and new problems constantly into the picture, tending to disrupt and upset all of our calculations

SEARS, ROEBUCK AND CO.

The 13 Periods for the Fiscal Year of 1935

1ST PERIOD	W	T	F	S	SUNDAY	M	T
January	*30*	*31*	F-1	2		4	5
February	6	7	8	9		11	12
February	13	14	15	16		18	19
February	20	21	22	23		25	26
2ND PERIOD							
February	*27*	*28*	M-1	2		4	5
March	6	7	8	9		11	12
March	13	14	15	16		18	19
March	20	21	22	23		25	26
3RD PERIOD							
March	*27*	*28*	*29*	*30*		A-1	2
April	3	4	5	6		8	9
April	10	11	12	13		15	16
April	17	18	19	20		22	23
4TH PERIOD							
April	*24*	*25*	*26*	*27*		*29*	*30*
May	1	2	3	4		6	7
May	8	9	10	11		13	14
May	15	16	17	18		20	21
5TH PERIOD							
May	*22*	*23*	*24*	*25*		*27*	*28*
May	*29*	*30*	*31*	J-1		3	4
June	5	6	7	8		10	11
June	12	13	14	15		17	18
6TH PERIOD							
June	*19*	*20*	*21*	*22*		*24*	*25*
June	*26*	*27*	*28*	*29*		J-1	2
July	3	4	5	6		8	9
July	10	11	12	13		15	16

7TH PERIOD	W	T	F	S	SUNDAY	M	T
July	17	18	19	20		22	23
July	24	25	26	27		29	30
July	31	*A-1*	*2*	*3*		*5*	*6*
August	*7*	*8*	*9*	*10*		*12*	*13*
8TH PERIOD							
August	14	15	16	17		19	20
August	21	22	23	24		26	27
August	28	29	30	31		*S-2*	*3*
September	*4*	*5*	*6*	*7*		*9*	*10*
9TH PERIOD							
September	11	12	13	14		16	17
September	18	19	20	21		23	24
September	25	26	27	28		30	*O-1*
October	*2*	*3*	*4*	*5*		*7*	*8*
10TH PERIOD							
October	9	10	11	12		14	15
October	16	17	18	19		21	22
October	23	24	25	26		28	29
October	30	31	*N-1*	*2*		*4*	*5*
11TH PERIOD							
November	6	7	8	9		11	12
November	13	14	15	16		18	19
November	20	21	22	23		25	26
November	27	28	29	30		*D-2*	*3*
12TH PERIOD							
December	4	5	6	7		9	10
December	11	12	13	14		16	17
December	18	19	20	21		23	24
December	25	26	27	28		30	31

13TH PERIOD	T	F	S	SUNDAY	M	T	W
January 1936	2	3	4		6	7	8
January	9	10	11		13	14	15
January	16	17	18		20	21	22
January	23	24	25		27	28	29

and constitutes a continuous challenge to the accountant and statistician, to find the means for compiling and presenting the vital facts and statistics of business so as to provide executives with proper working tools for waging the continuous battle against waste and inefficiency to insure business a profit when conditions indicate such as the reasonable expectancy.

Our conclusions after five years of operations under the thirteen period calendar are simply this: That it has resulted in definite advantage to our company because it has improved the general comparability of our accounting and statistical records of the business to the extent that they have become more useful instruments as a means for period to period control and correction of merchandising and operating conditions to a much greater extent than was previously possible under the twelve months calendar.

That the actual additional cost, if any, is unimportant when considered against the better use that has been made of the material in the way of improved results and in the wider and constantly increasing knowledge of facts relating to the business and their significance that it is so apparent has been acquired by all of our key executives.

While this to some extent may be considered an intangible, and something that cannot be measured exactly in dollars and cents, we know without any question of doubt that it has meant a great deal of money to our company since the adoption of the 13-period calendar.

There are in the United States nearly 100 organizations which operate on the 13-period plan. Comments received from a large number of these indicate that it is much more satisfactory than operating under the 12-month calendar. Nearly 500 firms have endorsed the idea of calendar simplification and the 13-month plan.

Those who have been working toward the acceptance by the world of a 13-month calendar with a "Peace Day" or "Year Day" added to make the necessary 365 days in the solar year, now have the entire matter before the League of Nations and these advocates of the 13-month calendar are hoping that the League of Nations will call an international conference to adopt a convention for the reform of the calendar.

Several departments of the United States government have coöperated with representatives from civil life in forming the national committee on calendar simplification for the United States. The committee working on this plan have coöperated with the departments of Commerce, Agriculture, the Treasury, Interior, the Navy, Labor and the Interstate Commerce Commission. This Committee was organized July 9, 1928, and has submitted to the Secretary of State a complete report and recommendations with a request that the Secretary of State

present this report to the League of Nations in order to bring about an international conference on calendar simplification.

PROBLEMS AND TECHNIQUES IN GENERAL SCIENCE

By Ira C. Davis

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The first essential in describing any technique or method is the definition or explanation of the terms used. Terms as given in educational literature are sometimes used carelessly. They do not mean the same thing to everybody. Sometimes it is difficult to understand what certain methods and techniques are because the different authors used identical terms to describe different procedures.

The three techniques I want to discuss refer to the demonstration, the experiment and the problem. What is a demonstration? What are its purposes? What is the best way to perform a demonstration?

The same questions may be asked about the experiment and the problem. There is at least one common element running through the three methods. There is a difficulty involved. The demonstration, the experiment and the problem should be a means of solving the difficulty. There should be a gradual increase from teacher planning and techniques to pupil planning and techniques. Some claim that a demonstration should give pupils new experiences. But are not these experiences a means of helping pupils solve some difficulty? The word difficulty is used here in a broad sense. A pupil may have difficulty in learning the meaning of a word, in understanding a principle, in visualizing some phenomena, in the development of scientific concepts, in the applying of principles to new situations, and in the solving of the problems that face him. A problem for a class in science is a recognized difficulty which can be solved by acquiring, selecting and applying information. Demonstrations, experiments and problem solving techniques supply the pupil with the plans and materials for solving difficulties. They should assist him in thinking through his difficulties and in recognizing them in different situations.

I believe there should be a gradual development in the use of the demonstration, the experiment and the problem. I make these distinctions. A demonstration is a means of introducing and solving difficulties. The plans and techniques are supplied by the teacher. In the experiment the plans are supplied by the teacher and the pupils perform the techniques. In the problem the pupils supply the plans and the techniques. There is a gradual shift from teacher planning and doing to pupil planning and doing.

The type of demonstration I am suggesting is much different than the one ordinarily used. The usual type may be described briefly in this way. The teacher states the difficulty or tells what is to be proven. The set-up of the apparatus is described and explained. The demonstrator gives all details connected with techniques, calls attention to everything that happens, gives the causes for the happenings and finally gives the conclusion. All of this time the pupils are being entertained but they find no reason for doing any real observing or thinking.

In contrast to this type I am suggesting the so-called silent demonstration. The teacher performs the techniques which have been carefully planned to lead the pupil along definite and progressive lines of thinking. The demonstrator does not state the purpose, describe what is done, or explain what happens. The pupils should raise questions about the demonstration after it has progressed to a certain point. By means of these questions, difficulties arise. The remainder of the demonstration should be so planned that these difficulties will be solved. In some cases pupils ask questions which a resourceful teacher can answer by means of a demonstration. When conditions like this arise, the pupils know the difficulty at the beginning of the demonstration.

In the silent demonstration the teacher performs the techniques. The pupils record in detail the techniques performed and the things that happen. As each step of the demonstration is completed, the pupils' observations and results are checked. If necessary some parts of a demonstration may be repeated. Frequently pupils should be asked to repeat the techniques performed by the teacher as a check of their observations. The demonstrator does not draw the conclusions for the pupils but helps them draw their own conclusions.

The teacher may answer the questions the pupils ask. This is done briefly and with very little explanation. If a pupil asks

the name of a piece of apparatus or substance used, the teacher may answer by writing its name on the board or by giving it orally. With this type of demonstration, much of the teacher's time may be spent observing what the pupils record on their papers. This helps the teacher get a better notion of how well the pupils are observing what is being done.

In the silent demonstration the responsibility for observing techniques and results is placed on the pupils and that is where it belongs. No doubt you are asking why I am suggesting the silent demonstration. This is one of the reasons. A demonstrator usually talks to cover up defects in a demonstration. It becomes easier to tell pupils what should happen than to actually demonstrate that such a thing does happen. The talking becomes an excuse for not demonstrating. If a teacher plans a demonstration to meet the anticipated difficulties pupils will have, there is no reason why the teacher should talk. The demonstration should do the "talking." If it does not, then there is something wrong with it and talking is an admission that something is wrong.

The silent demonstration requires much more careful planning than the teacher talking type. This is the general plan that needs to be followed:

1. Setting the beginning point of the demonstration. What can the teacher safely assume the pupils know?
2. Analyzing the difficulty into steps of learning and performing the demonstration to meet each step in the difficulty.
3. Performing techniques so they are observable by the pupils in all parts of the room.
4. Giving the pupils some sort of plan for recording the results. This may be done by the use of mimeographed outlines or by indicating the steps on the blackboard. This plan should also provide for a summary of the results of all parts of the demonstration.
5. Giving pupils some general plan for drawing conclusions.
6. The teacher should provide a number of thought questions to help pupils apply the results of the demonstration in other situations.
7. The teacher should also provide a few experimental problems to give pupils an opportunity to use the method of the demonstration in solving problems of a similar nature. This gives pupils an opportunity to be original and also a chance to give their demonstrations before the class.

Many will want to know what types of pupil activities are occurring during such a demonstration. The pupils observe; they ask questions; some go to the desk to observe a certain detail more carefully; they record results; they are asked to watch for the controls and variables; they have a discussion if there is a difference of some kind; and they check their own papers with the correct observations and results, or they may exchange papers. They also develop as rapidly as possible the difficulty that the teacher is solving by means of the demonstration. They draw conclusions and through the thought questions and experimental problems apply their conclusions in several different situations.

In using the so-called silent type of demonstration for sometime, I am convinced that it has several advantages over the teacher-talking type.

1. It requires more thorough planning on the part of the teacher.
2. It creates more interest.
3. It causes more thorough observation.
4. It helps pupils see more clearly problems and difficulties in a laboratory situation.
5. It trains pupils to interpret results with greater accuracy.
6. It provides a great deal of material for application through the questions pupils ask.
7. It gives pupils an opportunity to show originality and demonstrate this originality to other members of the group.
8. Through the emphasis on the recognition of controls and variables, it gives pupils a better understanding of the fundamentals of experimentation.

No doubt several will claim that the teacher-talking type accomplishes all of these results. My observations compel me to say that I have not seen such results anywhere. Many times I have heard pupils ask their teachers, "What are we going to have today?" and when the teacher says a demonstration, they all appear to be pleased. They know very well they are going to have an easy day. Does any teacher actually believe the pupils are expecting to do a piece of real, thoughtful work in a situation like this?

GENERAL PLANS FOR THE DEMONSTRATION OF THE BAROMETER

It is assumed that pupils know:

1. Air occupies space.

2. Air has weight.
3. Air exerts pressure.
4. Liquids rise in exhausted tubes.

I. Set-up of demonstration and materials used. What teacher does.	I. Observations pupils make. Questions may be used to direct observations.
a. Pours mercury in dish.	a. _____
b. Exhibits glass tubes of different lengths, one open at both ends, others closed at one end.	b. _____
c. Tubes are placed in an erect position and clamped to a meter stick. Observations are checked.	c. _____
II. Tubes of different lengths are placed with open ends down in the dish of mercury. Observations are checked.	II. _____
III. a. Two tubes, one about 20 inches long and the other more than 30 inches, are filled with mercury and inverted in the dish of mercury. Vertical height measured.	III. a. _____
b. Then the longer tube is tilted toward the side. Vertical height measured. Observations are checked. Purpose of demonstration is developed.	b. _____
IV. a. A barometer tube is set up with the tube in a bottle so the air may be removed with an air pump. The height of the mercury is measured. Then air is removed. Air is admitted again. Then removed again. Admitted again.	IV. a. _____
b. More air is forced into the bottle with a bulb. Observations are checked.	b. _____

V. Pupils make a summary of results and observations for parts I, II, III, and IV.

VI. Pupils write their conclusion. (The purpose of the demonstration is stated and answered.)

THOUGHT QUESTIONS

These questions have been asked by pupils and suggest several problems.

1. How is the height of the mercury measured on the school barometer?
2. Does the size of the tube affect the height to which the mercury is held?
3. Do all parts of the barometer tubing need to be the same size? Must it be made of glass?
4. How may the space above the mercury be proven to be a vacuum?
5. What would happen if a barometer tube filled with mercury to its usual height was transferred to a dish of water without losing the mercury from the tube?
6. What uses are made of barometer readings? Why do they differ from day to day?
7. Could water be used to make a barometer? Why isn't it used?
8. Is dry air heavier or lighter than moist air? How do the barometer readings prove it?
9. How do "doll barometers" work?
10. Can a barometer be made without using a liquid?

EXPERIMENTAL PROBLEMS

1. A boy tried to make a barometer out of a piece of glass tubing 20 inches long. Did he succeed? Why?
2. A boy found at home a piece of small copper tubing, 18 inches long, a short piece of rubber tubing, and a piece of glass tubing 16 inches long. The glass tubing was open at both ends. Explain how this boy could make a barometer from this material, assuming that he had enough mercury and that there was a gas stove in his home.
3. How is the pressure in automobile tires measured? How is the pressure gauge made?
4. You are quite sure that the gauge you are using is not correct. How could you prove it? Would changes in air pressure affect its accuracy?

We have always been told that the difficulty should be stated for every experiment. Another way of stating the same thing—pupils should always know what problem or difficulty is to be solved and the complete directions which are given for solving it.

I question this procedure. To me it is deductive and not a method of solving a real difficulty by a scientific procedure, nor does it give pupils training in the scientific method. Why should the problem be stated? Rather than do the above, I am suggesting this procedure for an experiment. Let the teacher give directions to pupils for doing certain things in the laboratory. After these things have been done, pupils should be ready to ask questions about what has happened. Out of these questions a difficulty will arise. The pupils discover the difficulty from what they do and observe. A skillful teacher will anticipate the questions pupils will ask. The directions for the remainder of the experiment will plan the things to be done in a way which will help the pupils answer their difficulty. By this procedure pupils learn to ask questions about what they see and soon acquire a "question asking" attitude. As pupils acquire

more techniques and become more familiar with the apparatus in the laboratory, the quantity of directions for doing things may be gradually decreased. When pupils have reached this stage the teacher asks them to plan their own procedures for solving their difficulties. This gives the teacher the opportunity to be a real guide and director.

The teacher should provide several thought questions and experimental problems to give the pupils an opportunity to apply the results of the experiment in similar situations. They need drill to fix the results of the experiment in their minds. The more practical the applications, the more real the experiment becomes.

What are the advantages of such a laboratory procedure? It tends to make experimental work a discovery process rather than a verifying process. It is more interesting. It requires better observation and interpretation of results. It gives the pupils the opportunity to plan procedures for solving the questions they ask themselves. They cannot go through a whole experiment and just follow directions mechanically. It also requires the pupils to observe the controls and variables as set up in the directions. In the usual type of laboratory work, pupils make but little progress in their ability to solve problems from the beginning to the end of the year.

ILLUSTRATION OF TYPE OF DIRECTIONS USED FOR AN EXPERIMENT

I. Fill a small dish nearly full of water. Cut strips of blotting paper, tablet paper, and paper toweling about one inch wide and three or four inches long. Suspend each strip so the lower end just touches the surface of the water.

II. Repeat part I using strips of cotton, silk, wool and linen.

III. Observe the small tubes placed in the dish of colored water.

At this point pupils are asked to state the purpose of the experiment in the form of questions. Here are some of the questions they ask:

1. Why does the water rise higher in some materials than others?
2. Why does it rise at all?
3. How high can water be made to rise this way?
4. Will other liquids act the same way?
5. Why didn't the water rise in the writing paper?
6. What is the name of this action?

IV. Directions which follow help the pupils answer these questions.

V. Thought questions and more problems.

After pupils have taken part in several demonstrations and experiments of this type, they are ready to begin solving simple problems. These problems arise from questions raised in the

demonstrations and experiments, from other questions pupils ask, from class discussion, or from the experiences pupils have outside of school. At first the problems should be simple and should be limited to one variable. If a pupil asks how carbon dioxide is used to put out a fire, carbon dioxide is the only factor to be considered. But it is an entirely different type of problem if the pupil should ask "how may fires be put out."

You will remember it was stated that pupils plan their own procedures for the problems. It usually follows this general plan. Through discussions and by recalling the experiences the pupils have had, the factors which should be considered in solving the problem are enumerated. With this list of factors as a beginning point, each pupil is asked to write directions for solving the problem. Then several pupils read their directions. Pupils then see the necessity of revising their directions because they have failed to control enough of the factors. It usually becomes necessary to agree on a method of controlling some of the factors. When this has been accomplished the pupils rewrite their plans. When the plans are acceptable, the pupils proceed to solve their problem. They summarize their results and draw a conclusion. If the plans are well made, and the techniques carefully performed, the conclusions drawn should answer the difficulty. Often other problems are raised and the solving of one problem has introduced several more.

Gradually more difficult problems may be introduced. If there are several variable factors to be considered, the class may be divided into groups and each group made responsible for determining what effect some factor might have in producing the results. This type of problem is solved on a coöperative basis, each group giving its results to all of the other groups. A general conclusion is drawn based on the results of all of the groups.

If pupils are given opportunities to solve eight or ten of these problems in a year, they should acquire a good understanding of how to solve them on a scientific basis. This accomplishes one of the objectives all teachers seem to agree on, that is, give pupils training in the scientific method.

These procedures which I have suggested for the demonstration, the experiment and the problem may be carried on in any school room. They do not require any more apparatus and materials than the usual procedures. Pupils are really interested and make definite progress in their methods and techniques.

They know they are making progress. They see how the development occurs. They feel they are a part of it.

If teachers will follow these suggested procedures for one year, and give them a fair trial, I am quite sure they will agree with me that the procedures offer possibilities for making science a discovery process for the pupils. They will learn that these procedures give pupils a method for discovering new truths. They will also learn they give pupils opportunities to plan ways of doing things for themselves.

We no longer need to discuss and argue which is best—the demonstration or the experiment. Under these suggested procedures both are fundamental. Both are steps in helping pupils learn how to solve problems. Both have their place. They supplement each other, yet they are different. To me it is useless to claim that one method is better than another. Why compare two things that are not the same? Rather than do this why not make each one mean something? Why not conduct each in a way that will produce the most desirable results? Why not make each of them a step in leading to problem solving?

If methods and procedures are successful it is not necessary to spread false propaganda in their behalf. Neither is it necessary to give them publicity of the ballyhoo type. But in order to have successful methods used by a greater number of teachers, it becomes necessary to let them know what others are doing. That is what I have tried to do today. All I ask is—give these methods a fair trial.

SULPHUR AND LIMESTONE COMBAT BACTERIAL WILT OF POTATOES

Sulphur and molasses used to be a standard springtime remedy for ailing small boys. Sulphur and limestone are proving to be a sovereign remedy for ailing potato fields in Florida.

Potatoes, and their close botanical relatives, eggplant and tomatoes, suffer severely from a disease known as bacterial wilt. The bacteria that cause it lurk in the soil, and hitherto it has been extremely difficult to deal with them.

At the meeting of the American Association for the Advancement of Science, Dr. A. H. Eddine of the Florida Agricultural Experiment Station, told how he had reduced the troublesome soil bacteria to helplessness by treating the fields first with sulphur—800 pounds to the acre—followed later on with 3,000 pounds of crushed dolomitic limestone per acre.

This treatment gave an increase of 63.5 bushels per acre of healthy marketable potatoes. Less than one per cent of the tubers in the treated plots were infected, compared with over 70 per cent infected in the non-treated plots. Eggplant and tomatoes gave even more striking increases in yield after the sulphur-lime treatment of the infected soil.

GEOMETRICAL CONSTRUCTIONS WITHOUT THE COMPASSES

By Walter H. Carnahan
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The very elementary problems of construction which presented themselves to the first Greek geometers were easily solved by use of the circle and straight line, the simplest of all loci. The definition of either of these figures is sufficient to suggest a tool for making it even though one has been limited to such primitive experiences as tethering an animal to a stake and seeing it draw a rope to a straight line and walk about the stake to make a circle. But when geometry had progressed beyond its first simple stages, problems were met, the solutions of which were not obvious and which, indeed, resisted all efforts to master them by the two simple and previously adequate loci. Most famous of these problems were the trisection of an arc, the squaring of the circle and the duplication of the cube. To solve these problems new loci were used, the quadratrix of Hippias and Dinostratus, the Conchoid of Nicomedes, the spirals of Archimedes, and the cissoid of Diocles.

These were loci the definitions of which did not suggest tools for their construction. In fact it is doubtful whether the Greeks ever had tools for making them. It must have been evident that the instruments if invented would be difficult of construction, hard to duplicate, inaccurate because of moving parts, and cumbersome to carry about. But these were not the chief difficulties. The statements of the problems of construction were in terms of loci of the simplest properties. It would hardly seem that a problem had been solved when its solution introduced loci of properties more complicated than those of the curve giving rise to the problem, especially if no tool had been devised for constructing the required curve. Then there was the desire to keep geometry as a mental pursuit and as free as possible from manual and mechanical associations which caused rejection by Plato and other logicians of the new loci in solution of geometric problems. For two thousand years after acceptance of the straight edge and compasses, the question of geometric tools was considered as finally settled. But recently it has been revived for occasional consideration.

Four years ago I discussed before this group the possibility of discarding the straight edge, and showed how to make with

the compasses alone every construction possible with compasses and straight edge. At that time I suggested the alternate possibility of making all geometric constructions without the compasses. I think it was not by way of "calling my hand" that your chairman asked me to appear on this program. Nevertheless, when I was asked to select my own subject, I naturally remembered my former talk under the general head of "unfinished business" and decided to begin where I then left off.

May I briefly review one part of the paper I presented four years ago? I pointed out that the straight edge had been a permitted tool for more than two thousand years before it was discovered how to construct one. The one I use was made by copying another which was a copy of another, which was a copy of ——— what? Only eighty-two years ago Sarraut invented the first machine for drawing a straight line. Then eleven years later, Peaucellier devised his well known linkage, and others have followed. I refer to these facts because the present discussion calls for extensive use of the straight edge and it is important that we be assured that we are using a tool that does in fact exist.

In order that we may have a definite understanding of the nature of geometric constructions, let us review the definitions of the fundamental figures used. A circle is the locus of points equally distant from a given point. A straight line is the locus of points in a given direction or its opposite from a given point.

Every geometric construction except the two elementary ones of drawing a line and drawing a circle involves the location of points to satisfy given conditions of direction and distance. Direction involves the construction of angles; distance involves linear measurement. Analysis of the constructions of geometry shows that they differ fundamentally as to the order in which the determination of direction and distance in locating a point must be done. One kind of construction requires the determination of direction first, then the measurement of distance on the direction-giving line from a point on the line. In other words, it requires the construction of an angle and the measurement of length from its vertex along a side. The other kind of construction requires the determination of distance from a point without direction being previously determined. In other words, it requires the construction of a circle whose intersection with a line determines direction from the center.

The first kind of construction can be done without compasses

if a way can be found to construct an angle equal to a given angle and transfer a given length onto a given line. We see at once that the straight edge alone will not suffice. If it be permitted to mark the straight edge, then it will serve as a means of marking off a given distance on the direction-giving line.

It is evident that the second kind of construction is impossible if we are not permitted to use any circle. However, if one circle is given and a way can be found to transfer its properties to situations requiring their use, the second kind of construction becomes possible even without the compasses.

Below, it is shown how to construct without compasses an angle on a given line equal to a given angle, and how to transfer length from place to place. Whence it follows that the first kind of construction can be done using only the straight edge and sect carrier.

Further, it is shown how to transfer without the compasses the properties of a fixed circle to situations requiring their use. This makes possible every construction that can be done with straight edge and compasses, postulating, of course, one given circle.

We may summarize the discussion as follows:

(a) If the compasses are discarded and every circle is lost and marking of the straight edge is prohibited, no geometric construction is possible.

(b) If the compasses are discarded and we are permitted use of the marked straight edge, it is possible to make constructions involving determination of direction and marking off given lengths on the direction-giving lines.

(c) If the compasses are discarded but one fixed circle is given, it is possible with the straight edge alone to make every kind of geometric construction now made with both tools.

Since some constructions are possible and others impossible with straight edge and sect carrier, it may be helpful if we list some constructions belonging to each class.

Possible constructions are:

Projection of a point range onto a given line;

To double a segment on a given line;

(these two constructions do not require marking the straight edge)

Construction of a line through a point parallel to a given line;

Construction of a right angle on a given line;

Construction of a line making a given angle with a given line;
Bisection of a line segment;
Bisection of an angle;
Construction of a right triangle given the hypotenuse and an acute angle;
Construction of a triangle given two sides and the included angle;
Construction of a triangle given a side and any two angles;
Construction of the complement and supplement of a given angle.

Impossible constructions are:
Construction of a triangle given the three sides;
Construction of a right triangle given the hypotenuse and a leg;
Construction of a line through a given point passing at a given distance from a given point (equivalent of the construction of a tangent to a circle from a point).

While the list of impossible constructions appears brief in comparison with the other, yet it will appear on investigation that few constructions can be made without the equivalent of the construction of a triangle given the three sides. This is the construction of the intersection of two circles.

Below are given the elementary constructions upon which others in each class depend.

It will be evident to one who follows the details of the constructions without compasses that they are too involved, laborious and inaccurate to permit serious consideration of permanent elimination of the compasses, just as permanent elimination of the straight edge is not to be recommended for the same reason. And if we continue agreement with the Greek mathematicians and logicians that the number of tools should not be extended, it seems that the question of permissible geometrical tools has its answer.

Constructions making use of a fixed circle involve the principles of direct and inverse similitude of circles, the method of finding corresponding points on two circles by using the centers of similitude, and the radical axis.

In the constructions given below, not all lines are shown in every figure because the page would then be a tangle of lines. In particular Fig. 8 would require 49 lines for the complete construction. Only 14 of these are shown. Those who have some interest in the subject can draw in the other lines.

Constructions Without the Compasses Given the Straight Edge and Sect Carrier

Construction I. Through a given point to construct a line parallel to a given line. Given line AB and point P. Draw PA and extend to C making $AC=PA$. Draw CB and extend to Q making $BQ=CB$. Draw PQ. Then PQ is parallel to AB.

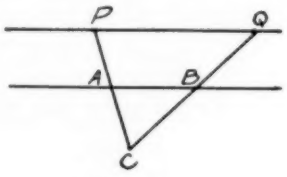

Fig. 1

Construction II. To draw a line perpendicular to a given line. Given line XY. From any point A on XY mark off $AB=AC$. Let D and E be any points not on XY such that $AD=AE=AB$. Draw BD and CE intersecting at F. Draw CD and BE intersecting at H. Draw FH intersecting XY at G. Then FG is perpendicular to XY. (B, D, E and C are concyclic. Hence CD and BE are altitudes of triangle FBC, and FH is perpendicular to XY.)

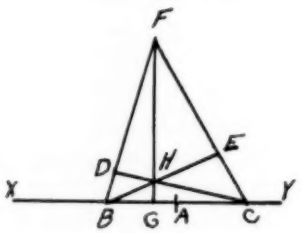

Fig. 2

Construction III. To draw a line making a given angle with a given line. Given the angle DAB and line FG. To draw a line making with FG an angle equal to angle DAB. Draw AC parallel to FG. Draw HK perpendicular to AC, and KL perpendicular to AD. Draw BD parallel to KL, and BC

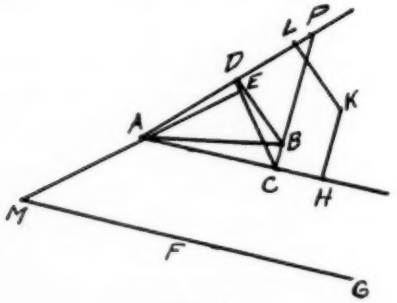

Fig. 3

parallel to HK. Draw CD. Draw AE perpendicular to CD intersecting FG at M. Then angle M equals angle DAB. (Rt. triangle ACP is similar to right triangle ABP. Therefore, $AP/BP=CP/DP$. Therefore triangle CDP is similar to triangle ABP. Therefore, angle ABP equals angle CDP. Hence, angle DCP equals angle DAB equals angle CAE equals angle M.

Given Straight Edge and One Fixed Circle

Construction IV. Through a given point to draw a line parallel to a given diameter of the circle. Let O be the fixed circle, PQ the given diameter and R the given point. Draw PR and QR. Let U be any point on PR. Draw UO intersecting QR at V. Draw QU and PV intersecting at S. Draw RS. Then RS is parallel to PQ.

Scholium. Note that the given circle is used in no way except to determine two equal lengths.

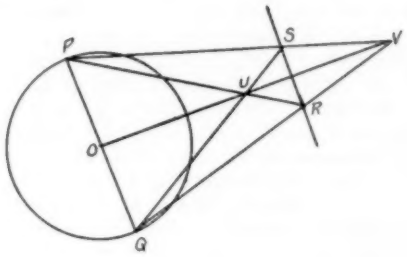

Fig. 4

Construction V. On a given line l find three points that determine two equal lengths. Let l be the given line. Let A be any point on l. Draw OA. Let B be any point on circle O. Draw BD parallel to OA and intersecting circle O at C. Draw diameters BB' and CC'. Draw $B'C'$ intersecting l at E. Then $EA=AD$.

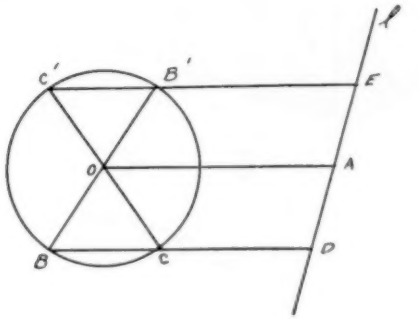

Fig. 5

Construction VI. Through a given point R construct a line parallel to a given line l. Let O be the fixed cricle. On l construct $AB=BC$. (II). Construct RS parallel to AB. (I).

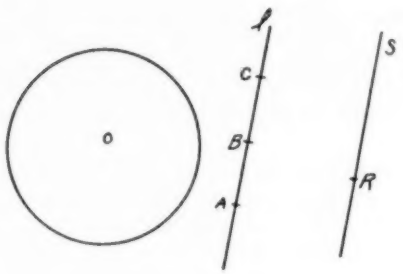

FIG. 6

Construction VII. To construct the points of intersection of a given line l and a circle which is not drawn but the center C and a radius CP of which are given. Construct AOB parallel to CP. (III). Draw OC and BP intersecting at D. BP intersects the fixed circle at E. Draw AD intersecting PC at F and the fixed circle at G. Draw AP intersecting OC at H. H and D are the centers of similitude of the fixed circle and the circle with center C. Draw GO intersecting the fixed circle at I. Draw EO intersecting the fixed circle at J. Draw IH intersecting AD at K. Draw JH intersecting BD at L. Draw BG and LF intersecting at M. Draw AE and KP intersecting at N. MN is the radical axis of the fixed circle and circle C. Draw MN intersecting the fixed circle at S at T, which are the required points of intersection.

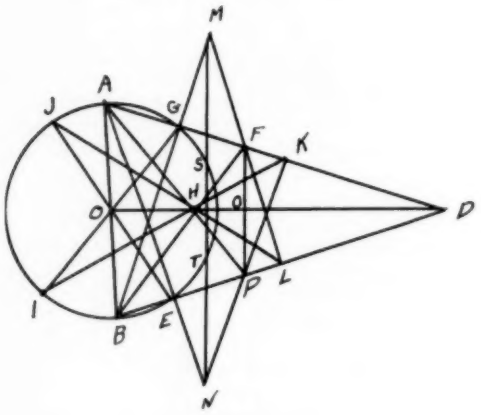

FIG. 7

Construction VIII. To construct the points of intersection of two circles which are not drawn, but the centers o and o_1 and radii oa and o_1c_1 of which are given. (This construction requires 49 straight lines. Fig. 8 shows only 14 of these.)

First, we construct diameters AOB and COD of the fixed circle parallel to the given radii of circles oa and o_1c_1 using Construction VI. The details of this construction are not shown on Fig. 8.

Second, we construct E and I, the centers of similitude of circles O and oa, and E', a center of similitude of circles O and o_1c_1.

(1). Draw Aa and Oo intersecting at E (2). Draw Cc_1 intersecting Oo_1 at E_1. (3). Draw Ba intersecting Oo at I.

Third, we construct b, the other end of diameter aob, and d_1, the other end of diameter $c_1o_1d_1$.

(1). Draw AI and ao intersecting at b. (2). Draw DE_1 and c_1o_1 intersecting at d_1

Fourth, we construct c and d, points on circle oa corresponding to c_1 and d_1. (1). Draw CE and DI intersecting at c. (2). Draw DE and co intersecting at d.

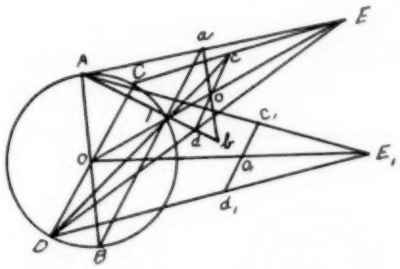

FIG. 8

14 of the 49 lines are shown

Fifth, we construct h and k, the intersections of cc_1 and dd_1 with circle oa, and h_1 and k_1, the intersections of cc_1 and dd_1 with circle o_1c_1. (This construction is not shown on Fig. 8.) (1). Draw cc_1 intersecting ao at f, and dd_1 intersecting ao at g. (2). Draw Ef intersecting AOB at FG. (3). Draw CF intersecting the fixed circle at H, and DG intersecting the fixed circle at K. (4). Draw EH intersecting cc_1 at h, and EK intersecting dd_1 at k. (5). Draw E_1H intersecting cc_1 at h_1, and E'_1K intersecting dd_1 at k_1.

Sixth, we construct mn, the radical axis of circles oa and o_1c_1. (This construction is not shown on Fig. 8.) (1). Draw hk intersecting o_1c_1 at l. (2). Draw h_1k_1 intersecting oc at m. (3). Draw lm intersecting ao at n.

Seventh, we construct x and y, the intersections of the radical axis mn with circle oa. (This construction not shown.) (1). Draw In intersecting AOB at N. (2). Draw Im intersecting COD at M. (3). Draw MN intersecting the fixed circle at X and Y. (4). Draw IX intersecting lm at x. (5). Draw IY intersecting lm at y.

x and y are the intersection points of circles oa and o_1c_1.

BALL LIGHTNING PARTLY A CHEMICAL EFFECT

Ball lightning, a phenomenon that has long puzzled meteorologists, is not a purely electrical effect, but electrochemical, declares Dr. E. Mathias, director of the Puy de Dome Observatory. He holds that these puzzling, slow-moving balls of blue fire that sometimes enter houses and bounce around in a mystifying, terrifying fashion, are generated by the loading of a certain quantity of atmospheric oxygen and nitrogren with an electrical charge which causes the "bubble" to glow.

An English physicist, Prof. T. R. Merton, has succeeded in producing something that resembles ball lightning inside glass tubes containing helium at very low pressures, by electrical discharges.

ATOMIC STRUCTURE PICTURE BOARD AND ITS USE IN THE CLASSROOM

By Clair L. Wade

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Every chemistry teacher is constantly looking for new and useful devices to aid him in his teaching program. You will find this board very useful in picturing the structure of the atoms, showing how the combining capacity (valence) is determined, picturing the migration and the sharing of electrons and showing how chemical activity is based on electrons.

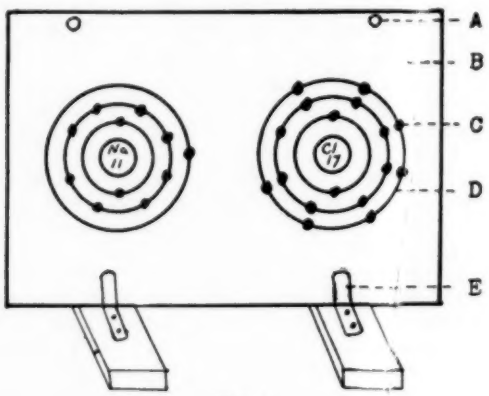


Fig. 1

A—Hole for hook if desired to be hung on the wall.
B—Ordinary bulletin board painted black. Plaster board may also be used.
C—Large white thumb tacks used for electrons.
D—Electron rings painted white.
E—Angle iron or small shelf bracket.

In Fig. 1, attention is called to the fact that the color is just the opposite from the actual print. The board is painted black and the electrons and the electron rings are white. The contrast of black and white makes an excellent picture. The stand for the board may be made by fastening angle irons or small shelf brackets to wooden feet in a position such that the board can be slipped down between them; the feet may be removed when the board is stored away. Holes may be drilled in the board or screw eyes placed in the top if you desire to hang it on the wall. I find an ordinary bulletin board ($2' \times 3'$) with a cork face answers the purpose very well. The blank maps are made from light cardboard. The size of the map may be made to suit the

individual, but I find the most convenient size for a map containing three orbits is $6\frac{1}{2}$ inches in diameter. Twelve blank maps should be enough for ordinary classroom demonstration, four with three orbits, four with two orbits, and four with one orbit. The nucleus is also made from cardboard about $1\frac{1}{2}$ inches in diameter. The blank map and the nucleus should be painted black, the electron rings, the symbols and the atomic numbers should be white. A thumb tack will hold the nucleus and also the map in place.

Fig. 1 shows that the sodium atom can be pictured very conveniently. All that is necessary is to obtain a blank map with three orbits and the sodium nucleus and secure it to the board by the use of one thumb tack through the center. Next,

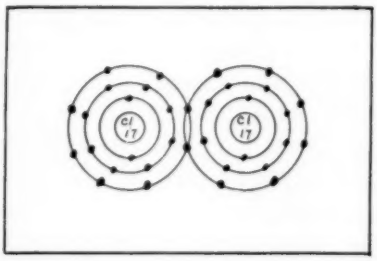


FIG. 2

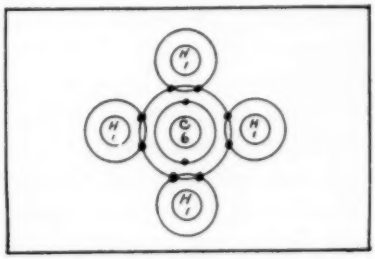


FIG. 3

place the eleven (atomic number) thumb tacks in their orbits as shown in the figure. The migration of electrons is very effectively taught when you can actually remove an electron (thumb tack) and place it in the orbit of another atom. You can very easily explain the valence of an element by this method. Usually the metals have relatively few electrons in the outer rings while non-metals have many. It can be shown that the chemical activity of an element is determined by the number of electrons it gains or loses in order to form an outer stable orbit. Thus sodium is more active than calcium. I know of no better way to show the sharing of electrons than by this picture board. Figs. 2 and 3 show the sharing of electrons in the formation of the chlorine and the methane molecule. Thus polar and non-polar compounds can be explained with ease.

This atomic structure picture board has proved to be intensely interesting as well as instructive to my pupils. I am now passing this information on to other chemistry teachers in the hope that it may aid them in bringing to their pupils a clearer understanding of the theories dealing with atomic structure.

THE BOTANICAL MUSEUM
PART II*

By Elwin D. Hull
Hull Botanical House, Gary, Indiana

DICOTYLEDONS. SYMPETALAE

Heath F. (*Ericaceae*): *Chimaphila* (Pipsissewa), *Moneses* (One-Flowered Pyrola), *Pyrola* (Shin Leaf), and *Arctostaphylos* (Bearberry) are northern evergreen forms, not hard to keep in the woodland terrarium provided with a highly acid soil. *Monotropa* (Indian Pipe), *Pterospora* (Pine Drops) and *Monotropsis* (Sweet Pinesap) are all dependent plants, better preserved in formalin. Apparently they cannot be kept alive. *Rhododendron* can be separated into two divisions, the first (Azalea group) being deciduous, and the other (Rhododendron group) evergreen. Azaleas are more or less common as conservatory plants. *Epigaea* (Trailing Arbutus) can be grown from seed in an acid soil and rather humid atmosphere. *Calluna vulgaris*, the famous Heather of Europe, is established along the Atlantic Coast in the U.S., and in several varieties is common in cultivation. *Vaccinium* contains the Blueberries and Cranberries, the species of greatest importance being *V. macrocarpon*, the cranberry found in the stores, native in bogs as far west as Arkansas, and easily kept in the bog terrarium.

Primrose F. (*Primulaceae*): *Primula* (Primrose), though a few species occur in the U.S., is not likely to be found in the wild, but in some varieties it is a common house and conservatory plant. *Cyclamen* is likewise very common in cultivation. *Trientalis* (Chickweed Wintergreen) is native to the U.S., and can be recommended for the deciduous woodland terrarium. *Dodecatheon* (Shooting Star) is a common native, mostly of prairies.

Olive F. (*Oleaceae*): These are all woody plants. *Olea* (Olive) contains Old World forms; the fruit of one, *O. europaea*, can be had at groceries, either green or mature. *Fraxinus* (Ash) can be found commonly in the wild, and is often cultivated. *Syringa* (Lilac), *Ligustrum* (Privet), and *Forsythia* (Golden Bells) are among the commonest cultivated shrubs, the Privet especially used for hedges.

* Part I of this article appeared in November, 1935.

Gentian F. (*Gentianaceae*): *Sabatia* (Sea Pink) has several species, mostly on the coastal plain, but with a few inland, *S. angularis* with angular stems being common in the Great Lake Region. *Gentiana* (Gentian) has many natives, the most common being *G. crinita* (Fringed Gentian), *G. puberula* (Prairie G.), *G. saponaria* (Soapwort G.), and *G. Andrewsii* (Closed G.). *Menyanthes* (Buckbean) is common in northern bogs, extending south to northern Indiana. *Nymphoides* (Floating Heart) is sometimes used in aquaria. It is not worth while attempting to grow the others indoors.

Milkweed F. (*Asclepiadaceae*): *Asclepias* (Milkweed) contains many native forms, some of them abundant weeds. Three good examples are *A. tuberosa* (Butterfly Weed) of sandy and dry fields, *A. incarnata* (Swamp Milkweed), whose habitat is indicated by the common name, and *A. verticillata* (Whorled Milkweed), especially common in prairies. *Hoya* (Wax Plant) is often cultivated, likewise *Stapelia* (Carrion Flower), the last a fleshy plant, somewhat cactus-like in appearance.

Morning Glory F. (*Convolvulaceae*): *Ipomoea* comprises the familiar Morning Glories, including the cultivated *I. quamoclit* (Cypress Vine), *I. purpurea* (Common Morning Glory), and *I. hederacea*, the last two common also as weeds, especially in corn fields. *I. Batatas* (Sweet Potato) is, of course, a well known vegetable. Some species of *Convolvulus* are native; one species, *C. arvensis* (Field Bindweed), is a common weed especially along railroad tracks, etc. *Cuscuta* (Dodder) has many species, parasitic on various plants, and better preserved in formalin.

Polemonium F. (*Polemoniaceae*): The commonest genus, *Phlox*, is native in many places, while others are common in cultivation. *Polemonium* (Jacob's Ladder) is found in rich woods in the eastern and central states. *Cobaea scandens* is a common climbing annual of gardens.

Borage F. (*Boraginaceae*): *Echium vulgare* (Viper's Bugloss) is a weed with brilliant blue flowers, occurring in meadows and along roadsides. *Mertensia virginica* (Bluebells) is a native of rich woods. Species of *Lithospermum* (Puccoon) can often be found as spring flowers in sandy soil. *Heliotropium peruvianum* (Common Heliotrope) is an abundant garden plant.

Vervain F. (*Verbenaceae*): *Lippia lanceolata* (Fog-Fruit) is common in wet soil. *Verbena* (Vervain) has native species, also introduced weeds, and *V. hybrida* (Common Garden Verbena) has long been cultivated in gardens. *Lantana* contains some

greenhouse plants, sometimes planted outdoors in summer.

Mint F. (*Labiateae*): Many common weeds belong here, including *Ajuga* (Bugle Weed), *Nepeta* (Cat Mint) with *N. Cataria* (Catnip) and *N. hederacea* (Ground Ivy), *Lamium* (Dead Nettle), *Stachys* (Hedge Nettle), and *Mentha* (Mint). Many of them are aromatic herbs, cultivated for their leaves, as *Merrubium vulgare* (Horehound), *Melissa officinalis* (Balm), *Thymus vulgaris* (Common Thyme), *Hyssopus officinalis* (Hyssop), *Mentha piperita* (Peppermint), *Rosmarinus officinalis* (Rosemary), *Lavandula Spica* (Lavender), and *Majorana hortensis* (Sweet Marjoram), *Coleus Blumei* (Coleus) contains foliage plants everywhere cultivated for house and bedding. Common wild species are found in the genera *Scutellaria* (Skullcap), *Dracocephalum* (Dragon Head), *Prunella* (Self-Heal), *Physostegia* (False Dragon Head), *Monarda* (Horse Mint), and *Pycnanthemum* (Mountain Mint).

Nightshade F. (*Solanaceae*): *Solanum* contains many weeds and garden vegetables. *S. Dulcamara* (Bittersweet) is an introduced vine, appearing almost as a native. *S. nigrum* (Common Nightshade) is an abundant weed in gardens; in a cultivated form it furnishes the Garden Huckleberries. *S. rostratum* (Buffalo Bur) is a native of the plains, but has spread eastward, and is now common; it is a very prickly plant. *S. tuberosum* is the common Potato, and *S. Melongena esculentum* is the well known Eggplant. *Lycopersicon esculentum* is the tomato, with many cultivated varieties. *Physalis* (Ground Cherry) has some native species, and *P. Alkekengi* (Chinese Lantern Plant) is common in gardens for the brilliant husk which encloses the fruit. Species of *Datura* (Jimson Weed) are common weeds, tall plants with prickly fruit. *Nicotiana* (Tobacco) includes the familiar Tobacco and some ornamental flowers. *Capsicum frutescens* is the Red Pepper. *Petunia hybrida* (Common Garden Petunia) is everywhere familiar; it may occasionally be found as an escape from cultivation. *Salpiglossis* and *Schizanthus* (Butterfly Flower) are likewise common garden annuals.

Figwort F. (*Scrophulariaceae*): *Verbascum Thapsus* (Common Mullein) and *V. Blattaria* (Moth M.) are common weeds, especially the former, the latter sometimes cultivated for ornament. *Linaria vulgaris* (Butter-and-Eggs) is a common weed. *Cymbalaria muralis* (Kenilworth Ivy) is a delicate vine, often cultivated in greenhouses and hanging baskets. *Antirrhinum* (Snapdragon) is one of the commonest garden annuals. *Scro-*

phularia (Figwort) is a common weed. *Penstemon* (Beard Tongue) has many native species of plains and prairies. *Chelone glabra* (Turtle Head) is more or less common in wet places, easily recognized by its tall habit and conspicuous white flowers. *Digitalis* (Foxglove) is common in gardens. *Gerardia* (False Foxglove) is common, especially the yellow flowered *G. flava* of oak woods and *G. tenuifolia* of open wet places, and with pinkish flowers. *Castilleja* (Painted Cup) with brightly colored involucral leaves is to be found in damp prairies, etc. *Pedicularis canadensis* (Lousewort) is a common spring flower. *Calceolaria* (Slipperwort) with sac-like inflated lower lip is a greenhouse plant.

Bladderwort F. (*Lentibulariaceae*): This contains the Bladderworts of quiet waters and wet places generally. *Utricularia vulgaris* (Common Bladderwort) is probably the most easily obtained. *U. cornuta* is an interesting plant, not floating as in the preceding species, with bladders usually not discoverable, but including only a stem and one or more bright yellow flowers. *U. minor* (Lesser B.) is valuable for aquaria, growing throughout the winter, unlike *U. vulgaris* which in the cold season exists only as winter buds. *Pinguicula* (Butterwort) has forms both American and foreign. It is an insectivorous plant in the simplest form. *P. elatior* of the southeastern U.S. is easily kept in the bog terrarium.

Broom Rape F. (*Orobanchaceae*): Members of this family are all root parasites. The commonest genera are *Epifagus* (Beech-Drops), found where beeches naturally occur, and *Orobanche* (Broom-Rape), found in damp woods, etc., throughout the U. S. By careful digging specimens can be secured attached to the host.

Bignonia F. (*Bignoniaceae*): These are all woody plants, with *Tecoma* (Trumpet Creeper) found wild in thickets, etc., and also common in gardens, *Catalpa* (Cigar Tree), both wild and cultivated, and *Bignonia* (Cross-Vine), an abundant climber in rich soil, mainly in the south.

Plantain F. (*Plantaginaceae*): *Plantago* is the important genus, having some of the commonest weeds, especially *P. major* (Common Plantain), a native species, and *P. lanceolata* (Rib Grass), a European species most abundant in grassland.

Madder F. (*Rubiaceae*): Common genera are *Galium* (Bedstraw) with both wild and introduced species, *Mitchella* (Partridge Berry), common in rich woods, *Cephalanthus* (Button-

bush), abundant in swamps, and Houstonia (Bluets), dainty wild flowers of early spring. *Mitchella* is one of the easiest plants to grow in the deciduous woodland terrarium.

Honeysuckle F. (*Caprifoliaceae*): *Diervilla* (Bush Honeysuckle) is a common shrub of dry places, as dunes, from the Atlantic Coast to the Great Lakes. *Lonicera* (Honeysuckle) has many species both wild and cultivated. *Linnaea borealis* (Twin-Flower) is a small trailing evergreen with flowers in pairs, found in northern regions throughout the world. It is especially interesting as being named for the "Father of Botany," Carolus Linnaeus. It has been recommended as a terrarium plant, requiring a highly acid soil. *Viburnum* contains many ornamental shrubs, three of which might be mentioned, these found both wild and cultivated, *V. Lentago* (Nanny-Berry), *V. prunifolium* (Black Haw), and *V. acerifolium* (Maple-Leaved Viburnum). *Sambucus* (Elder) is a well known plant of open rich places throughout a large part of the U.S.

Teasel F. (*Dipsacaceae*): *Dipsacus* (Teasel) has prickly flower heads; in the Fullers Teasel (*D. fullonum*) these are used for raising the nap on cloth. This European plant may be found about wool mills in the eastern and middle states; it is cultivated in New York State. *D. sylvestris* (Wild Teasel), likewise from Europe and similar in appearance, may be found along roadsides.

Gourd F. (*Cucurbitaceae*): *Cucurbita foetidissima* (Missouri Gourd) is a plant of the plains, sometimes found along railroads, etc., in the east. *C. Pepo* is the Field Pumpkin, while *C. maxima* contains the autumn and winter squashes. *C. Pepo ovifera* includes the Yellow-Flowered Gourds, frequent as ornamental vines. An interesting collection of the fruits of these can be made; they are of many shapes, like pears, apples, eggs, etc., and are variously colored. *Luffa* (Sponge Gourd) is interesting in that the dried fibers of the interior of the fruit are used as a sponge. *Lagenaria* contains the White-Flowered Gourds, with the shells used for utensils, being variously shaped like bottles, clubs, etc. *Citrullus* is the well known Watermelon, a hard fleshed race being the Citron used in the making of conserves. *Cucumis sativus* is the common Cucumber. *C. Melo* is the Muskmelon with many varieties, as var. *reticulatus*, the Muskmelons proper, and var. *cantalupensis*, the Cantaloupes. *Echinocystis lobata* (Wild Balsam-Apple or Cucumber Vine) is a common native of the eastern and central states in rich soil, as in river

bottoms; it is also commonly cultivated, and may be found as an escape. The fruit is covered with soft prickles. *Ecballium Elaterium* (Squirting Cucumber) of the Mediterranean Region is sometimes grown as a curiosity. It has probably the most unique method of seed dispersal known. The fruit at maturity becomes detached from its stem, and squirts its seeds through the point of attachment.

Bellflower F. (*Campanulaceae*): *Campanula* is the common genus. *C. rapunculoides*, a plant of Europe and Asia, one of the old fashioned flowers, has escaped from gardens, and is common in some regions, especially along roadsides and in thickets. *C. rotundifolia* (Harebell) is a native species, widely distributed in northern regions, and found south in the U.S. to the dunes of Lake Michigan in northern Indiana. *C. Medium* (Canterbury Bells) and *Platycodon grandiflorum* (Balloon Flower) are common garden plants.

Lobelia F. (*Lobeliaceae*): The most striking member of this family is *Lobelia cardinalis* (Cardinal Flower), found in low grounds in the eastern and central states, and blooming in late summer and autumn. Often found with it and flowering at the same time is *L. siphilitica* (Great Lobelia), with blue flowers instead of red. *L. inflata* (Indian Tobacco) is a poisonous plant of dry open fields and woods, "a noted quack medicine" (Gray's Manual).

Composite F. (*Compositae*): This very large family is conveniently divided into two sections, *Tubuliflorae* with the head composed entirely of disk flowers, or both disk and ray flowers present, the latter marginal, and *Liguliflorae* with the head composed entirely of ray flowers. Common genera having disk flowers only are *Vernonia* (Ironweed), *Eupatorium* (Thoroughwort), especially *E. purpureum* (Joe-Pye Weed) and *E. coelestinum* (Mist-Flower), and *Liatris* (Blazing Star). With both disk and ray flowers are *Solidago* (Golden-Rod), *Bellis* (Daisy), *Aster*, *Erigeron* (Fleabane), including *E. pulchellus* (Robin's Plantain), an early spring flower in woods, and *E. canadensis* (Horse-Weed), native of America but now scattered throughout the world, *Antennaria* (Everlasting), woolly plants among the earliest spring flowers, *Ambrosia* (Ragweed) with both sterile and fertile heads. *A. trifida* (Giant Ragweed) being abundant, especially in bottom lands, and *A. artemisiifolia* (Bitter-Weed) common almost everywhere, *Xanthium* (Cocklebur), common weeds with spiny heads, *Rudbeckia* (Cone-Flower), especially

R. hirta (Black-Eyed Susan), *Helianthus* (Sunflower), *Coreopsis* (Tickseed), especially *C. lanceolata*, native and much cultivated, *Bidens* (Bur Marigold), *Achillea* (Yarrow), *Chrysanthemum*, *C. leucanthemum pinnatifidum* (Ox-Eye Daisy or Whiteweed) being a common and harmful weed in meadows, and the garden and greenhouse Chrysanthemums being everywhere known, *Artemisia* (Wormwood), including the well known Sage of desert regions, and many other forms, *Senecio* (Groundsel), with several native species, and *S. succulentus*, a succulent of South Africa, good for the desert terrarium, *Calendula* (Pot Marigold), one of the commonest garden and pot flowers, *Leontopodium* (Edelweiss), a noted Alpine flower, easily grown in the desert terrarium, *Tagetes* (Marigold), well-known garden flowers, especially *T. patula*, the dwarf French Marigolds, and *T. erecta*, the African Marigolds, both species from Mexico, *Arctium* (Burdock), abundant weeds, *Cirsium* (Thistle), and *Centaurea* (Star Thistle), *C. Cyanus* being the Bachelor's Button of gardens, and *C. Cineraria* (Dusty Miller) being likewise a common garden plant with whitish leaves. Among the genera with the flowers all ligulate may be mentioned *Cichorium* (Chicory), sometimes used as a substitute for coffee, common in places as a weed, especially along railroads, *Tragopogon*, with *T. porrifolius* (Oyster-Plant) of gardens and occasionally escaped, and *T. pratensis* (Goat's Beard) rapidly becoming a common weed, both species striking in fruit, somewhat like immense dandelions, *Taraxacum* (Dandelion), with *T. officinale*, the common species, everywhere known, and *T. erythrospermum* (Red-Seeded D.), rapidly becoming common, often occurring with the preceding, *Sonchus* (Sow Thistle), common weeds, *Lactuca* (Lettuce), especially *L. scariola integrata* (Prickly Lettuce), an exceedingly abundant weed with yellow flowers, *L. spicata*, a blue-flowered species of low grounds, and *L. sativa*, the well known garden vegetable with several forms, *Prenanthes* (Rattlesnake-Root), usually stout plants with nodding heads, and *Hieracium* (Hawkweed), with both native and introduced species, a few of them becoming common and pernicious weeds.

PLANT ORGANS

The plants named are usually cited merely by way of example. Other species may be equally as good.

Unless otherwise noted dry pressed specimens will be best.

LEAVES

Cotyledons: Five specimens will be needed for a complete preparation. They will include above ground (epigaean) germination (Castor Bean), below ground (hypogaean) germination (Garden Pea), elongation of cotyledon (Date Palm), cotyledons resembling foliage leaves (Garden Nasturtium), and cotyledons unlike foliage leaves (Morning Glory).

Parts of Leaves: Some leaves have all the parts, namely, blade, petiole and stipules, present (Rose), others consist only of blade and petiole (Lilac), while still others have but the blade, in which the leaf is said to be sessile (Spiderwort).

Arrangement of Leaves: There are three types, alternate (Willow), opposite (Privet), and whorled (Trillium).

Venation of Leaves: This preparation includes the netted-pinnate (Milkweed), netted-palmate (Maple), and parallel (most any monocot except Trillium) types.

Forms of Leaves: The commonest forms are linear (Grass), lanceolate (Black Willow (*Salix nigra*)), ovate (Lilac), cordate (Common Blue Violet), oblong (Common Mouse-Ear Chickweed (*Cerastium vulgatum*)), orbicular (Nasturtium), deltoid (Cottonwood (*Populus deltoides*)), spatulate (Bearberry (*Arctostaphylos Uva-ursi*)), truncate (Tulip Tree), and hastate (Arrowhead). An asymmetrical leaf should also be shown (Hackberry (*Celtis*)).

Apexes of Leaves: There are five types, as mucronate (Indian Hemp (*Apocynum*)), obtuse (Flowering Spurge (*Euphorbia corollata*)), acuminate (Wild Black Cherry (*Prunus serotina*)), acute (Apple), and retuse (False Indigo (Baptisia)).

Margins of Leaves: Ten types will give a good preparation; these are entire (Lilac), serrate (Willow), dentate (Large-Toothed Poplar (*Populus grandidentata*)), undulate (Milkweed), spinose (Christmas Holly), lobed-pinnate (White Oak), lobed-palmate (Maple), pinnatifid (Dandelion), compound-pinnate (Rose), and compound-palmate (Clover).

Attachment of Blade and Petiole: This shows the two forms of attachment of blade with petiole, the basal, represented by the great majority of leaves, and the peltate, well shown by the common Garden Nasturtium, or the aquatic Water Shield (*Brasenia Schreberi*).

Surfaces of Leaves: Six common types are pubescent (Downy Yellow Violet (*Viola pubescens*)), hirsute (Blue-Weed (*Echium vulgare*)), glabrous (Lilac), tomentose (White Poplar (*Populus*

alba) under surface), scaly (*Shepherdia canadensis*), and glandular (House Geranium).

Hair Production in Leaves in Various Environments: This preparation shows two leaves of the Water Knotweed (*polygonum amphibium*), widely distributed in wet places, a glabrous floating leaf from an aquatic specimen, and a hairy leaf from a plant not submerged.

Motile Leaves: This mount shows the open and closed leaves of a Sensitive Plant (*Mimosa pudica* or *Cassia*), a leaf of *Oxalis* in day position (open) and one at night (closed and drooping), the Hair Cap Moss (*Polytrichum*) in dessication, in which the leaves are closely appressed to the stem, and in moisture, in which the leaves are widely spreading, and the leaves of the Common Juniper (*Juniperus communis*) in winter (appressed) and in summer (spreading).

Variation in Leaves of Sassafras: Sassafras seems to vary in its leaves without regard to environmental conditions. There are three sorts, entire, two-lobed, and three-lobed.

Transition from Aquatic to Aerial Leaves: A single plant of the Mermaid Weed (*Proserpinaca palustris*) will show the extreme type of submerged leaf, finely dissected, and the aerial form where the leaf is practically entire, and transition forms in between these two.

Juvenile and Adult Leaves: Seedlings of the Arbor-Vitae (*Thuya occidentalis*) will show at first awl or needle shaped leaves, and later, on lateral branches, the scale leaves of the adult condition. The Harebell (*Campanula rotundifolia*) has rounded leaves in the juvenile stage, and linear, almost grass-like, leaves on the flowering stems. The Yellow Pond Lily or Spatterdock (*Nymphaea advena*) has at first short-petioled, decidedly arrow-shaped leaves, these entirely submerged, and later long-petioled, oval, and floating adult leaves. Another water lily (*Castalia*) shows the same features, but the juvenile and adult leaves are more alike in general outline. Seedlings of both species can be found in summer in shallow water in ponds where the adults also occur.

Absorption by Leaves: The Water Fern (*Salvinia*) has two sorts of leaves, the floating rounded and entire, and submerged, elongated, feathery leaves, the latter being absorbing organs in the absence of roots. A bog moss (*Sphagnum*) and a woodland moss (*Leucobryum*) not only have special organs of absorption in their leaves, but the stems are closely packed together, form-

ing a cushion, an effective aid in the absorption of water. *Salvinia* will best be shown in formalin, the other two can be mounted dry in jars, a method by which the cushion habit can be well observed.

Water Leaves with Inflated Petioles: In the Water Hyacinth (*Eichornia crassipes*) the petioles are much inflated and filled with air, aiding this floating plant to maintain its position. The Water Chestnut (*Trapa natans*), naturalized in some parts of the eastern U.S., and to be had of some dealers in aquatics, likewise shows this feature though perhaps not so well. These leaves are best shown in formalin.

Reproduction by Leaves: The Life Plant (*Bryophyllum*) is the most used; young plants arise from notches in the leaf when this is severed from the stem. A Water Fern (*Ceratopteris*) with floating leaves gives rise to many plants on the upper surface. This is a southern plant, and can be had of some dealers. Leaves of certain plants, as the Hen-and-Chickens (*Echeveria secunda*) can be removed from the parent, and laid on moist soil in a moist atmosphere, and young plants will be put out from the base.

Scale Leaves: This preparation shows the various positions which scale leaves occupy, as on subterranean stems (Rush), on dependent seed plants (Indian Pipe), on photosynthetic stems (Horsetail), subtending cladophylls (Garden Asparagus), and subtending flowers (the head of a Composite is excellent).

Leaves as Tendrils: In the leaf of a Vetch (*Vicia*) the terminal leaflet is modified to form a tendril.

Leaves as Thorns: In the Black Locust (*Robinia Pseudacacia*) the stipules form thorns, and are persistent when the remainder of the leaf falls.

PLANTS BECOME VERY SICK WHEN DEPRIVED OF BORON

Boron, an element most familiar in the common household chemicals, borax and boracic acid, is indispensable for the normal growth of plants. They need only a minute trace of it, but if deprived of that minimum quantity they become very sick.

Consequences to corn plants of boron starvation were described by Dr. E. T. Eltinge of Mount Holyoke College, speaking before the meeting of the American Society of Plant Physiologists. The plants soon lost their normal green color, their young leaves failed to unroll, their root tips became swollen and stunted, and by the end of three weeks growth had practically ceased.

THE THIRTY-FIFTH ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

The Thirty-fifth Annual Convention of the Central Association of Science and Mathematics Teachers was held last November 29th and 30th in the Palmer House, Chicago, Illinois. The physical surroundings and most adequate accommodations of the Palmer House together with the skill with which the president, Miss Katharine Ulrich, and the Chairman of the Local Arrangements Committee, Mr. John K. Skinner, managed the Convention resulted in perhaps the most successful meeting in the history of the Association. Great credit also is due the Chairmen and members of the various other committees, all of whom cooperated efficiently in putting on the program.

THE EXHIBITS

The Exhibits, a feature always interesting to the members, were given a most prominent position in a large room just outside the Grand Ball Room where the General Sessions were held. Mr. W. H. Clark, who was in charge of these exhibits, received commendation from both exhibitors and members alike as the arrangement provided a place where members could converse and observe the exhibits at the same time.

THE THURSDAY EVENING MEETING OF THE BOARD OF DIRECTORS

On Thursday, November 28, the evening preceding the Convention, the Board of Directors met in Room 7 on the Third Floor of the Palmer House. Many problems affecting the business of the Association, the business of the Journal and the operation of the Convention were considered. This preliminary meeting, just as it has always done in previous years, cleared the way for the smooth running of the Convention on the following morning.

THE FRIDAY MORNING GENERAL SESSION

The Friday morning general session was held in the Grand Ball Room on the Fourth Floor of the Palmer House, opening at nine o'clock with two violin solos by Eugene Kolinsky of Wright Junior College, Chicago. This was followed by a vocal solo by William R. Fisher, after which the Wright Junior College Male Ensemble sang and the musical program was concluded by a vocal duet by Gordon Ferguson and Sidney Singer.

The president, Miss Katharine Ulrich, then introduced Mr. Charles M. Turton, of Chicago, who gave the Address of Welcome. Mr. Turton has been a loyal, active member of the Association since its organization, having been one of the six physics teachers who met in May 1901 in a vacant room down town in Chicago and formed the Central Association of Physics Teachers with *School Science* as its official organ. This journal was started in April of that year by C. E. Linebarger, who was the physics teacher at the Lake View High School, Chicago. Mr. C. H. Smith, of Hyde Park High School, was president and Mr. Linebarger secretary. The first Annual Meeting was held during the Thanksgiving Recess 1901 in Armour Institute. This was so successful that teachers of Mathematics and the others sciences asked that they be allowed to come in and thus form one large association. Accordingly, at a meeting held at Armour Institute in April 1902 the Central Association of Science and Mathematics Teachers was formed. During the summer of 1903 Mr. Linebarger started *School*

Mathematics, a journal for mathematics teachers, but during the summer of 1904 he stopped publication of both journals. Mr. Turton was then secretary of the Association and received many complaints from our members because of the non-receipt of these journals. At the Annual Meeting that fall this was the all-important topic of discussion. Finally, the late Charles H. Smith, of Hyde Park High School, Chicago, and Mr. Turton, of Bowen High School, were persuaded to take over the journals and combine them into one journal, which they did, purchasing the journal from Mr. Linebarger. They issued their first number as of January 1905, No. 1 of Volume 5. This numbering still is followed. After the death of Mr. Smith, Mr. Glen W. Warner purchased Mr. Smith's interest in the Journal and Messrs. Turton and Warner published the Journal until in 1928 the Association (which had become incorporated in 1926) purchased it from the private owners and has since operated it under the present management, Mr. Turton retiring after having been publisher for twenty-four years. Thus Mr. Turton was able in his Address of Welcome to review in a most interesting way the entire history of the Central Association. Mr. Turton said in brief:

"For the twenty-fifth time Chicago welcomes the Central Association of Science and Mathematics Teachers. During its thirty-four years of existence, the Association has met here in Chicago twenty-five times. This is fitting and proper as Chicago is in the center of the territory of the Association and is easier of access to the majority of its members than any other place. Chicago now has thirty-seven public high schools and three public junior colleges. There are also as many private and parochial secondary schools. In the suburban territory within twenty-five miles of this room are also fifteen additional public high schools. Chicago welcomes the Association because, with its Journal, SCHOOL SCIENCE AND MATHEMATICS, it has done so much to improve the methods and practice of teaching the various sciences and mathematics. In this respect it has done more than all other agencies combined. In its early days in its programs, the Perry Movement of England was brought to the attention of American teachers. A committee, headed by our Mr. C. E. Comstock, of Peoria, issued a monograph on 'Correlation of Mathematics and Physics.' This brought about great improvement in teaching and was a great help to us physics teachers. The new movement in the teaching of physics of about twenty-five years ago originated in the programs of the Association and was then sponsored by its journal. This movement practically revolutionized the teaching of physics. Textbooks on unified courses in Mathematics owed their inspiration first to the programs of the Mathematics Section. For these reasons, the teachers of Chicago welcome the Central Association again. As a Chicago Physics teacher, I consider it a great honor to be enabled to extend this welcome. We hope and expect that this meeting will be one of the greatest and best meetings it ever has held."

Miss Lillian Hethershaw, of Drake University, Des Moines, Iowa, gave the "Response For the Association." Miss Hethershaw was Vice-Chairman of the Elementary Science Section and spoke of the progress made in developing an integrated twelve year science program.

Dr. William J. Bogan, Superintendent of the Chicago Public Schools, then spoke on "Science in the Junior Colleges." This was of interest to the members of the Associations, as the new Junior Colleges of Chicago are organized on a unique plan in which survey courses are offered to large groups. Of these survey courses, two are in the fields of the Natural Sciences one being in the physical sciences and one in the biological sciences. The content of each of these is chosen to provide human interest and the broad understanding of principles of modern science. These courses comprise a

portion of the general education which should be the possession of every citizen. Mr. Bogan pointed out that the chief objective in junior college science should be science for the layman and that education must strive to provide a broad and general education. He also stated that more science is needed in the high school also but not of the specialized type.

Following Mr. Bogan's address, Mr. S. A. Campbell, Conservationist and Lecturer, of River Forest, Illinois, spoke on "The Real Meaning of Conservation." His lecture was illustrated with moving pictures of Wisconsin forest life taken at his wild life sanctuary at Eagle River, Wisconsin. Some of the films were in the new color effect "Kodachrom." Many very beautiful scenes in natural colors were shown, especially sunrise and sunset scenes.

Dr. George D. Birkhoff, of Harvard University, then lectured on "The Relation of Mathematics to Art, Poetry, and Music," after which the session adjourned for twelve o'clock lunch.

THE ANNUAL RECEPTION

The Annual Reception was held between five and six Friday afternoon in the foyer on the Fourth Floor where the Exhibits were displayed. The reception was sponsored by representatives of the Women's Mathematics Club of Chicago and vicinity.

THE ANNUAL BANQUET

The Annual Dinner was held in the Grand Ballroom on the Fourth Floor of the Palmer House at six P.M., being served in the manner for which the Palmer House is noted including their famous waiters' parade.

Dean Arthur C. Becker, Director of the School of Music, DePaul University, Chicago, Illinois, played a piano solo and other music was furnished by the DePaul University Ensemble.

Mr. O. D. Frank, of the School of Education, University of Chicago, acted as toastmaster and in his characteristically delightful way presented the speakers of the evening who included Miss Ada L. Weckel, a past president of the Association, Dr. J. S. Georges, member of the Board of Directors, Miss Marie Gugle, Assistant Superintendent of Schools, Columbus, Ohio, and a past president of the Association, Mrs. Marie Sangernebo Wilcox, chairman of the membership committee, Mr. Ira C. Davis, member of the Board of Directors, and Dr. Otis W. Caldwell, the second president of the Association and an honorary member of the Association.

The Address of the evening was given by Dr. Arthur Koehler of the U. S. Forest Products Laboratories, of Madison, Wisconsin. Dr. Koehler was the wood expert who played so prominent a part in the conviction of Hauptmann in the Lindbergh kidnapping case. He presented in the most interesting and convincing way the many bits of evidence which led to the person who was convicted. The illustrations showed in the most graphic manner how the characteristics of the wood left no doubt as to the relationship between the wood used in the ladder and the material from which the wood was taken.

THE FRIDAY AFTERNOON SECTION MEETINGS

(*Edited by* KATHARINE ULRICH)

BIOLOGY SECTION

The Biology Section was called to order November 29, 1935 at 2:00 P.M. by Mrs. O. Olive Dunham, Chairman. The Secretary, John W. Kendrick was also present.

The Nomination Committee consisting of the following members, A. C. Brookley, Harvey, Illinois; N. A. Neal, Cleveland, Ohio; and O. D. Frank, Chicago, Illinois, was appointed.

The first speaker was: Earl C. Wright, Curator of Museum Exhibits, Chicago Academy of Science, Chicago, Illinois. His subject was "The Preparation of Museum Exhibits." Mr. Wright said that he did not wish to make taxidermists out of the members, but illustrated with pictures the various steps in the preparation of birds, skins, and then the steps in mounting birds—a process much more difficult. Methods of preparation of skins of mammals and their preservation were also illustrated and clearly explained. Teachers can do much by way of creating interest by preserving birds, mammals, etc., brought into the class room by pupils.

The second speaker was Jerome Isenbarger, Wright Junior College, Chicago, Illinois. His subject was "Biological Science in the Junior Colleges." Mr. Isenbarger explained the new method used in the Junior Colleges of presenting science to groups with 300 students or more. Three lecture-demonstrations are given to the large groups each week. These large groups are then broken up into groups of 45 for quiz and discussions or explanations if necessary. Mr. Isenbarger gave a résumé of his paper in order that Dr. Roemmert might have the opportunity of demonstrating the micro-vivarium. The paper will appear in full in an early issue of the Journal.

The third speaker was Dr. G. Roemmert, Chicago Science Museum. His subject was "A Demonstration of the Micro-Vivarium." Dr. Roemmert projected living protozoans on the screen so that the members could see them. He showed structural details and functions, actual reproduction and food getting of these forms. He followed this with a display of many celled forms showing the structure and functions of these forms in living materials. We saw heart beating, intestinal reactions and movements, the respiratory system and its functioning. Dr. Roemmert also demonstrated how teachers could perform experiments on these forms while the class observed and also that the effects of different stimuli could be observed. This was followed by demonstrations of crystallization and showed clearly how this took place; then with polarized light he demonstrated the color effects on these developing crystals. The use of the micro-vivarium in the classroom would result in much more effective teaching, particularly in large classes.

The fourth speaker was Dr. Theodore E. Boyd, Head of Physiology Department, Loyola University School of Medicine, Chicago, Illinois. His subject was "The Physiology of Nerves." Dr. Boyd traced the structures and early knowledge of nerves. Then he presented newer ideas. He showed the effects of different stimuli on nerve fibers and the responses of these. The response was about the same, but the rate of frequency varied, e.g., the rate of movement of response varied from four miles an hour to 270 miles an hour.

The fifth speaker was Dr. Alfred Emerson, Department of Zoology, University of Chicago, Chicago, Illinois. His subject was "Termite Society." Dr. Emerson has recently returned from a six months study of Termites in the Canal Zone. Termites are very highly developed socially and eat food which is one of the hardest to digest—wood. They are able to digest this wood on account of protozoans that live in their stomachs. They live in tropical regions but get as far north as Chicago. They produce more offspring than any other known animal. Colonies are made up of the queen, the king, the soldiers that fight enemies other then termites, and the workers. All but the king and queen are blind. The new queens and kings develop wings which are lost after they migrate to new locations. The male and female start a new colony, and new kings and queens may be produced if these are lost. In tropical countries they produce wonderful homes that are marvels on account of their architectural characteristics

These protect them against rain and storms. The new termites never have an opportunity to learn to build these homes as the workers build them and they are given birth to in the new home and do it instinctively. The adaptations of termites show they are very old. The fact that a group of ant-eaters have developed so highly as to live on these, and fossil remains also show they are very old.

The report of the Nominating Committee was accepted. The section officers for 1936 are:—Chairman, R. B. Simon, Western Reserve Academy, Hudson, Ohio; Vice-Chairman, John W. Kendrick, Arsenal Technical Schools, Indianapolis, Indiana; Secretary, Lillian Bondurant, Oak Park High School, Oak Park, Illinois.

The meeting was adjourned.

JOHN W. KENDRICK
Secretary

CHEMISTRY SECTION

The Chemistry Section was called to order November 29, 1935 at 2:00 P.M. by M. J. W. Phillips, Chairman. The Secretary, J. L. Van Horn; Vice-Chairman, A. R. Stacy; and the Acting Secretary, Mabel E. Dittmar were also present.

The Nominating Committee consisting of the following members, R. E. Davis, A. P. Minsart, and Mr. Pestelozzi was appointed.

The first speaker was Dr. Harold Mermore, Chief Chemist of Derby Oil Company. His subject was "Demonstration of the Refining of Petroleum." This was a very impressive demonstration of the processing of crude oil from the oil pumps and derricks through the entire refining process. The glass equipment was accurate in detail and made it possible to illustrate the fractional distillation of crude oil and the cracking of hydrocarbons—a method by which topped crude is decomposed into gasolene and kerosene. Both the recharging method and the continuous process of fractional distillation were demonstrated. Dr. Mermore also showed that cracked gasolenes containing olefine compounds and aromatic hydrocarbons give higher octane number, thus permiting the use of higher compression ratios. Acid purification and anti-knock gasolene were explained. Charts and samples of refined products added to the interest of this valuable demonstration.

The second speaker was Dr. W. W. Theisen, Assistant Superintendent of Schools, Milwaukee, Wisconsin. His subject was "Modern Trends in Teaching as Applied to Chemistry." Dr. Theisen is of the opinion that the learning of facts is not the objective of our teaching, and that the teaching of chemistry is not the learning of facts. Chemistry teaching should follow the objectives of education in general, only using chemistry to reach the objectives, viz: to provide the child with ideas, ideals, appreciation, ability to think and apply problems. He urged that the methods used should employ motivation to secure interest.

The third speaker was Dr. Nicholas Cheronis, Wright Junior College, Chicago, Illinois. His subject was "Physical Science in the Chicago Junior Colleges." His paper will be published in the *Journal of Chemistry Education*. The survey course forms a part of a definite chemistry college course as well as general course. Dr. Cheronis, who demonstrates his chemistry lectures to three hundred students at one time, displayed some of his equipment which he uses to enable all to observe. Huge test tubes, special lighting, mirrors, and visual instruction including slides and mirrors all help in his method. His experiments are all shown on an exceptionally large scale. Whether the demonstration or the individual method of instruction is superior is still questionable, but for large numbers the demon-

stration *introduces* the physical sciences particularly well. It enables the teacher to select those who are to become specialists and prevents weak pupils from specializing in physical sciences.

The report of the Nominating Committee was accepted. The section officers for 1936 are:—Chairman, Allan R. Stacy, George Washington High School, Indianapolis, Indiana; Vice-Chairman, J. L. Van Horn, Lincoln High School, Cleveland, Ohio; Secretary, R. E. Whitney, Marshall High School, Chicago, Illinois.

The meeting was adjourned.

MABEL E. DITTMAR
Acting Secretary

ELEMENTARY SCIENCE SECTION

The fourth meeting of the Elementary Science Section was called to order November 29 at 2:00 P.M. by Florence Billig, Chairman. The Secretary, Geraldine Shontz, and Vice-Chairman, Lillian Hethershaw were also present.

The Nominating Committee, Consisting of the following members, Jennie Hall, Minneapolis, Ellis C. Persing, Cleveland, and Bertha Parker, Chicago, was appointed.

An interesting and instructive program was given as follows: The first speaker was Glenn Blough, Michigan State Normal College, Ypsilanti, Michigan. His subject was "Science in the Elementary School Program." Mr. Blough believes that persons interested in science education should become better acquainted with the general aims of elementary science education. Such knowledge is important because it adds understanding of the contribution which the sciences make toward the attainment of these goals. He said that science should contribute much toward the growth of an elementary child. It should help him become more alert and interested in his surroundings, establish in him the beginnings of a scientific attitude, give him usable scientific subject matter, and bring about an appreciation of environmental factors.

The second speaker was Mary Melrose, Supervisor of Elementary Science, Cleveland Public Schools, Cleveland, Ohio. Her subject was "The Radio and Elementary Science." Miss Melrose believes that the radio is one of the great aids of the elementary science teacher. She presented ways in which the radio is being used in the Cleveland schools and pointed the way to a much wider use of radio in the near future.

The third speaker was Dr. Otis W. Caldwell, Professor Emeritus, Teachers' College, Columbia University, New York City. His subject was "Science, a Way of Living." Dr. Caldwell stated that the results of scientific advancement have not been adequately utilized in the schools. The spectacular achievements in scientific knowledge become the usual. It is the obligation of the teacher to distribute knowledge concerning these achievements and their meaning to the pupils. Of course knowledge does not always change our way of living. However, the young can be taught to seek and accept facts concerning superstitions.

The fourth speaker was Paul Edwards, Director of Visual Education, Chicago Public Schools, Chicago, Illinois. His subject was "Visual Materials in the Teaching of Science in the Elementary Schools." Mr. Edwards pointed out that visual education saves time, brings in things from other parts of the country, increases the size of minute things, and brings things in the child's environment to his attention. He showed some very excellent motion pictures of materials available for use in science classes.

Bertha M. Parker, University Elementary School, The University of Chicago, Chicago, Illinois, led the general discussion. Many questions

were raised on the papers given by Mr. Blough and Miss Melrose. The discussion ended with the question, "Why has elementary education in science progressed so slowly?"

The report of the nominating committee was accepted. The section officers for 1936 are as follows: Chairman, Lillian Hethershaw, Drake University, Des Moines, Iowa. Vice-Chairman, Geraldine Shontz, Indiana State Teachers' College, Terre Haute, Indiana. Secretary, Glen Blough, Michigan State Normal College, Ypsilanti, Michigan.

Mr. Ellis C. Persing made the following resolution: That the Elementary Science Section heartily approves of the action of the Board of Directors to appoint a committee to work out a plan for membership of elementary science teachers, and further, in order to keep the interests of the section before the committee, one member be chosen from the Elementary Science Section. It was moved and seconded that the resolution be adopted. The motion was carried.

An attendance of between 200 and 250 persons made the meeting a successful one.

The meeting adjourned at 4:30 P.M.

Signed, GERALDINE SHONTZ
Secretary

GENERAL SCIENCE SECTION

The General Science Section was called to order November 29, 1935 at 2:00 P.M. by Leonard B. Johnson, Chairman. The Secretary, Carl F. Hanske, and Vice-Chairman, Alma Thomas being also present.

The Nominating Committee consisting of the following members, L. H. Fuller, Boys' Technical High School, Milwaukee, Wisconsin; W. F. Worthley, F. W. Parker School, Chicago, Illinois; and E. W. Campbell, Lane Technical High School, Chicago, Illinois was appointed.

The first speaker was Ira C. Davis, University of Wisconsin. His subject was "Problems and Techniques in a General Science Class Room." Mr. Davis discussed three techniques—the demonstration, the experiment, and the problem. He brought out the fact that the demonstration, the experiment and the problem should be a means of solving the difficulty, and that there should be a gradual increase from teacher-planning and techniques to pupil-planning and techniques. In contrast to the usual type of demonstration, he suggested the so-called silent demonstration where the teacher performs the techniques which have been carefully planned to lead the pupil along definite and progressive lines of thinking. The pupils raise questions about the demonstration after it has progressed to a certain point, and by means of these questions, difficulties arise. The remainder of the demonstration is so planned that these difficulties will be solved. As each step of the demonstration is completed, pupil's observations and results are checked—some parts of the demonstration are repeated, and, finally, the teacher does not draw the conclusions for the pupils but helps them to draw their own.

The second speaker was Joseph E. Teder, Lake View High School, Chicago, Illinois. His subject was "The Anti-Vivisection Propaganda and Its Relation to the Teaching of Science in Our Public Schools." Mr. Teder's paper was a plea to all real educators and true humanitarians that they not only lend their moral support, but that they use common sense in protecting the handful of active workers from the meddlesome interference of a group of misguided sentimentalists, who in the name of mercy, would condemn future generations to remain helpless victims of biological ignorance.

Dr. Georges Van Biesbroeck, Professor of Astronomy, Yerkes Observa-

tory, The University of Chicago, Williams Bay, Wisconsin was unable to appear on the program as scheduled because of illness. Dr. Van Biesbroeck's report on "What Phases of Astronomy Should Best Be Taught in General Science for the Ninth Grade?" was to have been illustrated with slides. Members of the section regret very much that Dr. Van Biesbroeck was unable to appear on the program.

The report of the Nominating Committee was accepted. The section officers for 1936 are:—Chairman, Miss Alma Thomas, Audubon Junior High School, Cleveland, Ohio; Vice Chairman, Carl F. Hanske, Emmerich Manual High School, Indianapolis, Indiana; Secretary, T. J. Kuemmerlein, Boys' Technical High School, Milwaukee, Wisconsin.

The meeting was adjourned.

CARL F. HANSKE
Secretary

GEOGRAPHY SECTION

The Geography Section was called to order November 29, 1935 at 2:30 P.M. by Helen Southgate, Chairman. The Secretary, Virgil O. Petty was also present.

The Nominating Committee consisting of the following members, Viva D. Martin, Helen Turner, and T. H. Finley, was appointed.

The first speaker was Dr. Don Carroll, Associate State Geologist, State of Illinois. His subject was "State Aid in Teaching Earth Science." Dr. Carroll explained that Illinois, through its geological department, is doing much to aid in the teaching of the geography of the State. Tours are conducted each year to each of the six sections into which the state is divided, and studies in the field are made of the fluorspar deposits of the south, the silica sand deposits of the Ottawa region, the coal mines, petroleum wells, etc. In addition, mineral collections, slides, lectures, and even lecturers, are available, together with a most important series of bulletins and maps. Teachers were urged to make use of all materials and services offered by the state. In the Exhibit Hall Dr. Carroll had an exhibit of Illinois minerals which attracted the attention of practically everyone.

The second speaker was Dr. H. O. Lathrop, chairman, Geography Department, Illinois State Normal University. His subject was "Human Geography as Related to the Zonation of Vegetation in the San Francisco Mountain Region." Man is profoundly influenced by his plant-life environment. The type and character of vegetation is conditioned by the basic factors of relief, soil, minerals, location, and climate. The farther one gets toward the pioneer fringe, the easier it is to see man's response to his natural environment. The San Francisco Mountain Range of Northern Arizona, being near the pioneer fringe, shows very admirabley this adjustment. The zonation of vegetation on the San Francisco Mountain Range is most striking. For number of zones, changes in short distances, and varieties of vegetation within small compass it has few equals. These zones were discussed under the following divisions: the desert, the Junipers and piñons, the Yellow Pine forest, transition zone, and the Sub-Alpine zone. The paper was illustrated with lantern slides. Due to the illness of Dr. Lathrop the paper was graciously read by Mrs. Lathrop.

The third speaker was Mabel Engstrom, Isaac Elston High School, Michigan City, Indiana. Her subject was "In Viking Land." The speaker was dressed in the costume worn by the inhabitants of Dalecarlia, a province of Northern Sweden. Motion pictures of Iceland, Norway, Sweden and Finland added to the understanding of these lands. Iceland, a volcanic island, has almost no trees. Hot springs are utilized as sources of hot water and heating of public buildings. Norway, with its incompar-

able fjords, has an abundance of water power. Sweden is a land of birchwood. It is more of an agricultural country than the other northern lands. Manufacturing of paper, furniture, and steel goods is important in Sweden. Finland, the land of 60,000 lakes, is famous for its railroad station in Helsingfors, the work of the architect, Saarineu. Lumber is exported. Viking Land offers many delightful travel experiences, such as the sight of the midnight sun.

The fourth speaker was C. L. Schenk, Assistant Secretary, Sears, Roebuck and Company, Chicago, Illinois. His subject was "A Discussion of Sears, Roebuck and Company's thirteen period Calendar." On January 1st, 1930, Sears, Roebuck and Company announced that it would conduct its business on the basis of a thirteen-period year instead of conducting it according to a twelve month calendar. It is believed that this company is the first large mercantile concern to adopt the thirteen-period calendar plan for its business. Since the calendar is a man-made device for keeping track of time, it has been altered many times to suit the needs of its users. Therefore, Sears, Roebuck and Company entered upon the thirteen period calendar plan in order to be able to make more definite and accurate comparisons than it is possible to make when operating on the twelve month calendar. In budgeting and budget control the thirteen period basis has made possible much in the way of improvement and refinement, principally because of the greater ease by which it is possible to distinguish trends and make comparisons. It has withstood five years' trial successfully. Today one hundred organizations operate on the thirteen period plan and five hundred firms have endorsed the idea of calendar simplification and the thirteen-month plan.

The report of the Nominating Committee was as follows:—Chairman; Virgil O. Petty, Berger School, South Holland, Illinois; Vice Chairman, Frederick J. Breeze, North Side High School, Fort Wayne, Indiana; Secretary, Ethel Mills, Soldan High School, St. Louis, Missouri.

Business Transacted was as follows: Moved by Viva D. Martin and seconded by T. H. Finley that:—Chair be authorized to appoint a local arrangement committee for next year. The motion carried.

The meeting adjourned.

VIRGIL PETTY
Secretary

MATHEMATICS SECTION

The Mathematics Section was called to order November 29, 1935 at 2:00 P.M. by J. Russell McDonald, Chairman. The Secretary, Beulah I. Shoesmith, and Vice-Chairman, C. J. Leonard being also present.

The Nominating Committee consisting of the following members, George E. Hawkins, E. D. Burton, and Marie Plapp was appointed.

The first speaker was Walter H. Carnahan, Shortridge High School, Indianapolis. His subject was "Geometrical Constructions Without the Compasses." Mr. Carnahan had given an address before the Mathematics section in 1931 in which he discussed the possibility of making all geometric constructions without the compass. In this year's address he continued that discussion and showed that (1) if the compass is discarded and every circle is lost and marking of the straight edge is prohibited, no geometric discussion is possible, (2) if the compass is discarded and we are permitted the use of the marked straight edge, it is possible to make construction involving the determination of direction and marking off given lengths on the direction-giving line, (3) if the compass is discarded and but one fixed circle is given, it is possible with the straight edge *alone* to make every kind of geometric construction now made with both tools.

The second speaker was Dr. Mayme Logsdon, University of Chicago. Her subject was "Non-Technical Functions of Mathematics." Dr. Logsdon urged that students be made aware of the unselfishness of scientific discovery and that they be taught mathematics as a mode of thinking. She suggested that it was perhaps more important to know what mathematics is about than to know how to practice it, and emphasized the importance of teaching an appreciation of our number system, the use of formulas and an acquaintance with historic problems.

The third speaker was Walter W. Hart, University of Wisconsin. His subject was "Improved Instruction versus Curriculum Tinkering." Mr. Hart made a plea for the creation of conditions favorable to teaching and learning and urged emphasis upon improving the technique of instruction rather than upon curriculum changing. Mathematics is worth while, it is valuable not only as a tool but as an instrument of culture, but its value is being endangered by too much experimentation. We need a moratorium on curriculum tinkering and more attention to the attitude of the teacher.

The report of Nominating Committee was accepted. The section officers for 1936 are:—Chairman, Mr. C. J. Leonard, Southeast High School, Detroit, Michigan; Vice-Chairman, Miss Vivian B. Ely, Washington High School, Indianapolis, Indiana; Secretary, Miss Eleanor Booher, Oak Park High School, Oak Park, Illinois.

The meeting was adjourned.

BEULAH SHOESMITH
Secretary

PHYSICS SECTION

The Physics Section was called to order November 29, 1935, at 2:00 P.M. by Mr. James P. Coyle, Chairman. The Secretary C. L. Brosey, and the Vice-Chairman, Emil Massey, were also present.

The Nominating Committee consisting of the following members, C. M. Turton, of Chicago, Illinois; Glen W. Warner, of Chicago, Illinois; and E. E. Burns, of Chicago, Illinois, was appointed.

The first speaker was Mr. M. W. Welch, of the W. M. Welch Scientific Company, who substituted for Dr. Glen M. Hobbs. His subject was "Some Effective Demonstrations in Elementary Physics." After a brief discussion of demonstration equipment, Mr. Welch was assisted by Mr. D. L. Barr, of Sterling Morton High School, of Cicero, Illinois, who gave a fascinating and instructive series of experiments on electromagnetic waves. He also demonstrated the spectra of a few substances and especially the luminescence of luminol.

The second speaker was Dr. Wilbur L. Beauchamp, of the University of Chicago, who spoke on the subject "Adapting Laboratory Work to a Five Period Schedule." Laboratory work should (1) develop power of observation and (2) give training in the art of translating observations into concrete examples, said Dr. Beauchamp. The problems should be such that the results cannot be predicted, they should be such that the pupils want an answer, and such that experiment is the only way of finding the answer. Conventional laboratory exercises should be discarded, and the total number of experiments reduced.

The third speaker was Dr. Harvey B. Lemon, of the University of Chicago, whose subject was "The Showing of University of Chicago Physical Science Talking Pictures." In his introduction to the pictures Dr. Lemon explained that pictures were not for the purpose of replacing the teachers. Rather, they were to supplement the work by showing experiments not otherwise possible. He said more experiments could be shown, that the experiments worked perfectly, that no "set up" of apparatus was

required, and that the accompanying lecture was concise, simple, and exact. Dr. Lemon showed the two films "Mountain Building" and "Fundamentals of Acoustics."

The fourth speaker was Mr. H. Clyde Krenerick, of North Division High School, Milwaukee, Wisconsin, who spoke on the subject "Methods of Accomplishing Laboratory Work in a Single Period." Mr. Krenerick expressed himself as opposed to two periods of laboratory time because it exhausts the pupils' time, thus giving no opportunity for home work. He said the previous compulsory preparation before entering the laboratory is the strongest feature of his plan. He would have correlation between laboratory work and discussion with the laboratory preceding the discussion. He has optional parts for better students, and the students, not the teacher, do the work.

The fifth speaker was Professor N. Henry Black, of Harvard University, whose subject was "The Effects of Modern Physics on Our Elementary Instruction." Dr. Black thinks the teaching of physics has become somewhat superficial because of so much material. We cannot add more without subtracting some from the present course, he says. He advocated the emphasis on laboratory work and stressed the close connection between physics and everyday phenomena. He said ours is the only country in which "modern physics" is taught. Other countries teach the well established fundamentals in elementary courses. He spoke of the progress made in the field of atomic physics, high pressure phenomena, radio engineering, air conditioning, and low temperature work, and said that physics was a growing applied science.

The report of the Nominating Committee was accepted. The Section Officers for 1936 are: Chairman, Charles L. Brosey, Arsenal Technical High School, Indianapolis, Indiana; Vice-Chairman, Louie R. Hull, South Side High School, Ft. Wayne, Indiana, and Secretary, N. A. Neal, East Technical High School, Cleveland, Ohio.

The meeting was adjourned at 4:45 P.M.

C. L. Brosey
Secretary

SATURDAY MORNING ANNUAL BUSINESS MEETING

November 30, 1935

The Annual Business Meeting was called to order at 8:15 o'clock by the President, Miss Katharine Ulrich.

Dr. Stone moved and it was seconded and carried that the minutes as printed in the March 1935 Journal be accepted.

Mr. Martin gave the Treasurer's Report.

Mr. Turton moved, and it was seconded by Dr. Stone and carried that the Treasurer's report be accepted.

Miss Ulrich announced that 300 full memberships were paid in on Friday.

Mr. Soliday reported approximately $190.00 taken in from single admission tickets.

The report of the Auditing Committee was made by Professor W. W. Hart, who read portions of the report of the Certified Public Accountant auditing the books of the Business Manager and praising the excellent condition of the business.

Mr. Turton moved, and it was seconded and carried that the report of the Auditing Committee be accepted.

Mr. Metcalf gave a verbal report of the audit of the Association books of last year, which was accepted on motion of Mr. Warner.

Mr. Roecker gave the report of the Business Manager, reporting a favorable balance but nothing was done with the report as a more complete report was to be made to the Board of Directors later.

Mr. Fred Schriever gave the report of the committee on Conservation as published in this issue. Mr. Frank E. Goodell of Des Moines moved and it was seconded by Miss Weckel and carried that the report of the Conservation Committee be accepted.

Mr. Turton gave the Necrology report.

Dr. Stone gave the report of the Place of Meeting Committee, giving as its decision that the Association should go to St. Louis next year.

Mr. Turton moved, and it was seconded by Mr. Schriever that this report be referred to the Board of Directors for final decision.

After some discussion in which Mr. Christy, Miss Gugle, and Mr. Turton presented the case of Cincinnati and Mr. Goodell spoke for St. Louis, the motion was put to vote and carried.

Mrs. Wilcox gave the report of the Membership Committee, telling of the plan for a permanent organization with a representative in every school.

Miss Weckel gave the report of the Resolution Committee as printed in this issue of the Journal. Mr. Warner moved and it was seconded and carried that the report be accepted and the Secretary instructed to send out the letters.

Mr. Teeters gave the report of the Nominating Committee as follows:

For President: O. D. Frank

For Vice President: Harvey M. Milford

For Members of Board of Directors

For Three Year term: N. A. Neal, Walter H. Carnahan, H. Clyde Krenerick, G. T. Franklin

To complete Mr. Milford's term: Charles S. Webb

To complete Mr. Frank's term: Charles A. Stone

Dr. Stone moved and it was seconded and carried that the report be accepted and the slate of officers elected

Motion to adjourn made by Mr. Gingery, and it was seconded and carried.

Respectfully submitted

ROSS B. WYNNE

Secretary

THE SATURDAY MORNING GENERAL PROGRAM

The Saturday morning general program was held in the Grand Ball Room at nine o'clock immediately after the Annual Business Meeting. The session opened with music by the choral club of the J. Sterling Morton High School and Junior College, of Cicero, Illinois.

The first speaker was Dr. Arno B. Luckhardt, of the University of Chicago, who spoke on "The Value of Animal Experimentation." He traced briefly the history of the study of human physiology and showed how animals are used for experimentation, referring particularly to his own researches and contributions. It does not seem possible that anyone, after hearing Dr. Luckhardt's explanation of how animals are used experimentally to solve problems affecting the health and welfare of the human race, could be affected by the current anti-vivisection propaganda. He urged that each teacher make it his business to see that the truth is presented to the pupils in his charge.

The second speaker was Dr. E. J. Moulton, Chairman of the Mathematics Department of Northwestern University, who spoke on the subject, "The Future of Mathematics." He discussed the great possibilities

of Mathematical research and drew an interesting picture of the number of volumes of mathematics that would be produced if mathematical research is continued as at present.

The third speaker was Dr. F. R. Watson, of the Acoustics Laboratories of the University of Illinois, who spoke on "Selected Topics in Acoustics." He performed several experiments for purpose of illustration. He first called attention to the old story about hearing the roar of the sea by placing the open end of the sea shell against one's ear. One could hear such a noise by simply holding a hand cupped over the ear. This phenomonon he explained as an example of sound reenforcement by illustrating how the sound from a tuning fork becomes greatly amplified when a box is brought near the vibrating fork. Dr. Watson pointed out that the scientist does not only correct erroneous and sometimes cherished ideas regarding natural phenomena but can achieve success in the field of invention as illustrated by the radio of to-day. He continued by explaining the acoustical nature of the tuning fork and told of an instrument for the measuring of the intensity of sound. A "loudness scale" was shown giving the relation between the physical energy and loudness as perceived by the ear

Energy Units. Log. 10 E.U.	
10	.100 decibels noise in airplane.
9	.90.
8	.80 noise in New York subway.
7	.70 noise in stenographic room.
5	.50 Range of speech as usually heard in conversation.
4	.40.
	.35 Soft radio music in an apartment.
1	.10 Rustle of leaves in gentle breeze.
.	Threshold.

A victrola was played, first with one door open and then with both doors open. The difference in loudness was three decibels. This allowed the audience to find out whether or not they could detect the difference. He then played a record at various degrees of loudness, 5, 10, 20, and 30 decibels. A damping device reduced the music to a barely audible murmur. Regarding the acoustics of school rooms, Dr. Watson said there is no more excuse for noisy classrooms. The acoustics of a building must be taken into account when the building is constructed. Ordinarily the acoustics problem is taken up after the building is completed, a treatment which would not be tolerated in the case of the heating problem.

THE SATURDAY AFTERNOON MEETING OF THE BOARD OF DIRECTORS

The Board of Directors met Saturday afternoon immediately after luncheon and transacted many items of business, clearing up the work of Miss Ulrich's administration. On account of the illness of the new president, Mr. O. D. Frank, the retiring president, Miss Katharine Ulrich, who continues as a member of the Board of Directors for another year, presided at this meeting. The Treasurer's report at this meeting showed the Association in good financial condition and that the Annual Convention had been conducted well within its income. All members will also be interested in knowing that at this meeting the Board decided unanimously to go to St. Louis for the 1936 Convention.

Since the close of the Convention President Frank has appointed as

Members of the Executive Committee, Miss Katharine Ulrich, of Oak Park, Illinois, and Mr. W. R. Teeters, of St. Louis, Missouri.

Combined Report Respectfully Submitted,
ROSS B. WYNNE
Secretary of the Association

NOTE FROM DR. DOWNING

Williams Bay, Wisconsin
December 2, 1935.

Mr. Ross B. Wynne, Secretary
Central Association of Science and Mathematics Teachers

Dear Mr. Wynne:—

I desire to express to members of the Central Association for the greetings and best wishes sent me from the Chicago meetings, my very sincere thanks.

Yours very truly,
ELLIOT R. DOWNING

REPORT OF THE NECROLOGY COMMITTEE

The Necrology Committee has only one death to report, that of William G. Shirer. Mr. Shirer was born in Iowa and educated at Cornell College, Mt. Vernon, Iowa, receiving the degree of A.M. His teaching experience began at Fountain, Minn., and ended as superintendent of schools at Buffalo, Minn. In 1909 he entered the educational book field as a traveling field representative of Henry Holt & Co. At various times he covered the states of Minnesota, Iowa, and Illinois. In 1920 he became manager of their Chicago office and soon after was a director and vice-president of the company. He died in July 1934 as the result of an automobile accident.

CHAS. M. TURTON
CHAS. LECKRONE

REPORT OF THE CONSERVATION COMMITTEE

MEMBERS OF THE COMMITTEE

Wm. G. Vinal, Western Reserve University, Cleveland, Ohio.
O. D. Frank, School of Education, University of Chicago, Chicago, Illinois.
J. L. Cooprider, Central High School, Evansville, Indiana.
W. R. Teeters, Board of Education Building, St. Louis, Missouri.
Louis E. Hildebrand, New Trier High School, Kenilworth, Illinois.
Fred Schriever, Chairman, Boys' Technical High School, Milwaukee, Wisconsin.

This committee, appointed November 29, 1930, has four times reported its findings. With some change in membership it is to continue the study of the question of Conservation Education in the Secondary School curriculum.

I. FINDINGS AND CONCLUSIONS OF THE COMMITTEE

As shown in our previous report these two facts seem to stand out:

(1) Conservation should, and may easily, be correlated with other subjects;—it need not be taught separately.

(2) Every school should take interest in some phase of conservation education, even though it be but little.

In the last four reports this committee has pointed out more in detail what might be done. We recapitulate and reaffirm the following approaches for Conservation Education:

(3) More emphasis of the conservation idea should be given by textbook writers and publishers.

(4) There should be increased availability of lists of bulletins, texts and agencies helpful in teaching conservation. The new Conservation Law in Wisconsin places this compilation upon the State Department of Public Instruction.

(5) Suggestive outlines for correlating conservation with other subjects should be provided.

(6) Textbook publishers may be induced to give certain subjects a conservation slant.

(7) Better teacher training for conservation education is imperative.

(8) All schools should avail themselves more of help to be derived from local, State, and Federal conservation agencies.

(9) Positive and effective leadership by our own Association in Conservation would insure progress. So far there has been none of note. It should be active, dynamic, purposeful, sincere, and continued until results are forth coming or assured.

II. Activities of the Committee

In view of the above findings, the committee sought, first, to have Conservation articles published, such as "The Bob-White Quail: A Unit of Work in Conservation"—William G. Vinal. This article appeared in the May 1935 issue of School Science and Mathematics.

An article on the Conservation Education Law in Wisconsin will appear in the near future. More such articles are desirable.

Secondly, the Chairman of the committee kept in touch with the Conservation Education Law as it progressed through the Wisconsin legislature. There was considerable correspondence with legislators and the viewpoint of our Association Committee was presented at the legislative committee hearing. Our Committee was only one of many organizations that helped.

Thirdly, the Committee still stresses the need for lists of bulletins, texts, and outlines for teaching Conservation. Here we may quote: "The State Department of Public Instruction (in Wisconsin) desires to be a clearing house for instruction materials and methods. Curricula are no longer written in offices as formerly. They are developed in class rooms with the cooperation of supervisors, teachers, and pupils."

This Wisconsin Law is given in full on page 941 of the December issue of School Science and Mathematics.

Respectfully submitted,

Fred Schriever
Chairman

OYSTERS FILTER BARREL OF WATER DAILY

Oysters filter a barrel of water through their bodies every day, sifting out the minute plants which are their food, and obtaining the oxygen to keep their very modest vital fires alight. At the meeting of the Zoological Society of America Dr. T. C. Nelson of Rutgers University told of his measurements of the efficiency of the oyster as a living pump.

The oyster's rate of handling water varies with the temperature. At about 50 degrees Fahrenheit very little water-filtering is done. Above this temperature the flow increases rapidly, to a maximum at about 85 degrees. During one seven-hour period, a single average-sized oyster, in water ranging between 75 and 80 degrees, filtered 111 liters of water—just about an even barrel.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

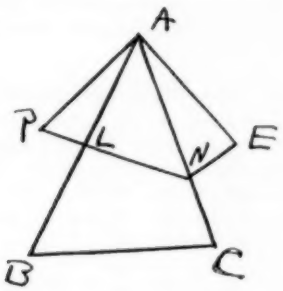
SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.



LATE SOLUTIONS

1400, 1407, 1411. *Charles W. Trigg, Los Angeles.*

1406. *Daniel Finkel, Brooklyn.*

1412. *Proposed by Samuel I. Jones, Nashville, Tenn.*

Given triangle ABC and a point, P, not on a side. It is required to draw a line from P bisecting the given triangle.

FIRST SOLUTION

Let ABC be equal the triangle and P the given point. Join AP and make $\angle CAE$ equal $\angle PAB$. Determine AE so that $PA \cdot AE = \frac{1}{2} AB \cdot AC$.

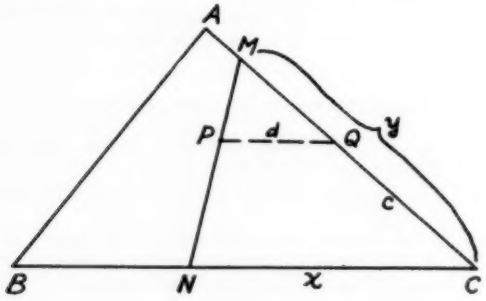
On segment PE describe an arc of a circle such that PE subtends an angle which is the supplement of $\angle LAE$. Let this arc cut AC in N. The line PN bisects the triangle ABC.

Proof: $LAEN$ is an inscriptable quadrilateral and $\angle ALN$ is supplementary to $\angle AEN$. Hence $\angle ALP$ equals $\angle AEN$. Since $\angle PAL$ equals $\angle NAE$ the triangles PAL and ANE are similar. Hence $PA:AL=AN:AE$, or $AN\cdot AL=PA\cdot AE=\frac{1}{2}AB\cdot AC$ from which it is seen that PN bisects the given triangle.

SECOND SOLUTION

This solution offered by Julius Freilich and Simon L. Berman, Brooklyn.

Analysis: Through P a point inside the triangle draw PQ parallel to BC. Let MN be the required line. Since triangle $MNC=\frac{1}{2}$ triangle, ABC, $xy=\frac{1}{2}ab$. Also $d:x=y-c:y$. Substituting the value of x, we obtain $2dy^2-aby+abc=0$. Since a, b, c, and d are known, y can be constructed, which enables one to locate M.



If P is selected outside the triangle, a similar quadratic equation results.

Solutions were also offered by Maxwell Reade, Brooklyn, and A. J. Patterson, Wheeling, W. Va.

1413. This is the same as problem 1402 solved in the December issue, 1935. Solutions now offered follow the same general plan, and since they were offered prior to the appearance of the December number, only the names of those offering solutions will be given. They are as follows:

Ruth Finger, Brockhaven, Miss., Simon L. Berman and Julius Freilich, Brooklyn, W. E. Buker, Leetsdale, Pa., A. R. Haynes, Tacoma, Wash., and Charles W. Trigg, Los Angeles.

1414. *Proposed by Amory R. Haynes, Lincoln High School, Tacoma, Wash.*

A cow is tethered to a post of the fence enclosing a five-acre circular field. What is the length of tether so that an area of one acre may be grazed over?

Solution by Charles W. Trigg, Cumnock College, Los Angeles.

Let x be the length of the tether, $r=$radius of the field, and θ and ϕ the angles indicated in the figure. Then $x=2r\cos\theta$, $\pi r^2=5$, $\angle OAB=\angle ABO=\theta$, and $\phi=\pi-2\theta$.

Area of sector $AOC=\dfrac{2\phi}{2\pi}\cdot\pi r^2=\phi r^2$.

Area of sector $ABCD=\theta x^2$.

Area of $\Delta ABO=\frac{1}{2}xr\sin\theta=\Delta BCO$.

Area of lune $ABCD=$sector $AOC+$sector $ABC-2\Delta BCO$.

$\phi r^2+\theta x^2-xr\sin\theta=1$. Since $\phi=\pi-2\theta$, $\pi r^2-2\theta r^2+\theta x^2-xr\sin\theta=1$. Substituting $\pi r^2=5$, and dividing by r^2,

$$2\theta - 4\theta\left(\frac{x}{2r}\right)^2 + \frac{2x}{2r}\sin\theta = \frac{4}{r^2}.$$

$$2\theta(1-2\cos^2\theta) + 2\sin\theta\cos\theta = \frac{4}{5}\pi.$$

$$\sin 2\theta - 2\theta\cos 2\theta = 2.513274.$$

$$2\theta = 2.44262 \text{ radians}$$

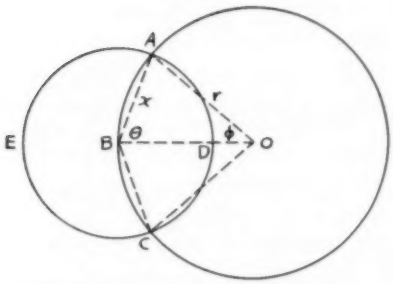
$$= 139°57'7''.$$

$$\theta = 69°58'33.5''.$$

$$x = 2r\cos\theta = 2\sqrt{\frac{5\times160\times121\times9}{\pi\times4}}\times0.34241$$

$$= 180.31 \text{ feet}$$

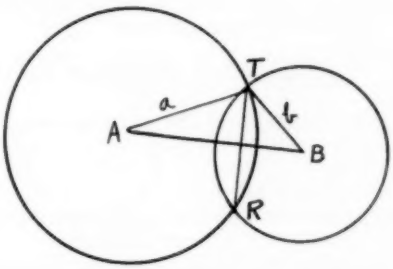
$$= 180 \text{ ft. } 3.7 \text{ inches.}$$



Solutions were also offered by Maxwell Reade, Brooklyn, and A. J. Patterson, Wheeling, W. Va.

1415. *Proposed by Dewey C. Duncan, Compton, Calif.*

Find the length of the common chord of two intersecting circles with radii a and b, if the segment of the line of centers common to the two circles is $2c$ in length.



Solution by David Blackwell, University of Illinois.

The sides of triangle ATB are a, b, $a+b-2c$. Then when $s = a+b-c$.

$$\text{Area triangle } ATB = \sqrt{s(s-a)(s-b)(s-a-b+2c)}$$

$$= \sqrt{(a+b-c)(b-c)(a-c)c}$$

$$\text{Also area triangle } ATB = \frac{TR}{4}(a+b-2c)$$

$$\text{Hence } TR = \frac{4\sqrt{(a+b-c)(b-c)(a-c)c}}{a+b-2c}$$

Solutions were also offered by W. E. Buker, Charles W. Trigg, A. R. Haynes, and Maxwell Reade.

1416. No solution has been received.

1417. *Proposed by a student.*

Prove $(n+1)^{r+1}-(n+1)=(r+1)S_n^r+\frac{(r+1)r}{1.2}S_n^{r-1}+\cdots+(r+1)S_n^1$

where $S_n^r=1^r+2^r+3^r+\cdots+n^r$.

This is the well known formula for finding the sum of the rth powers of the first n whole numbers and is easily derived by means of the Binomial Theorem. Refer: C. Smith, "Treatise on Algebra" 1900 Macmillan & Co., London, Pg. 404.

$$(n+1)^{r+1}=n^{r+1}+(r+1)n^r+\frac{(r+1)r}{1.2}n^{r-1}+\cdots+1.$$

$$[(n-1)+1]^{r+1}\equiv n^{r+1}=(n-1)^{r+1}+(r+1)(n-1)^r+\frac{(r+1)r}{1.2}(n-1)^{r-1}+\cdots+1$$

$$[(n-2)+1]^{r+1}=(n-1)^{r+1}=(n-2)^{r+1}+(r+1)(n-2)^r+\frac{(r+1)r}{1.2}(n-2)^{r-1}+\cdots+1$$

. . . . . .

$$3^{r+1}=2^{r+1}+(r+1)2^r+\frac{(r+1)r}{1.2}2^{r-1}+\cdots+1$$

$$2^{r+1}=1^{r+1}+(r+1)1^r+\frac{(r+1)r}{1.2}1^{r-1}+\cdots+1$$

The number of successive expansions is n.

The first term of each right hand member is in turn expanded in the following expansion. Hence by addition, all of the first terms, except 1^{r+1}, at the right, vanish. The sum of the second terms is $(r+1)S_n^r$. The sum of the third terms is $\frac{(r+1)r}{1.2}S_n^{r-1}$ and so on, the sum of the last terms being n. Adding the uncancelled 1st term of the last expansion to the sum of the last terms gives $(n+1)$.

Therefore, by addition

$(n+1)^{r+1}=(r+1)S_n^r+\frac{(r+1)r}{.2}S_n^{r-1}+\cdots+(n+1)$, which by transposition of the last term reduces to the original.

A solution was also offered by Charles W. Trigg, Los Angeles and Maxwell Reade, Brooklyn.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

1406. Max Fowler and Henry Wingo, Centralia (Ill.) H. S., Arthur Anderson, Donald Adler and Cora Turner, Tobet (Ill.) Township H. S.

PROBLEMS FOR SOLUTION

1430. *Proposed by Isadore Chertoff, Bayonne, N. J.*

Show that in any triangle the ratio of a symmedian to its corresponding median is the same as the ratio of twice the product of the including sides to the sum of their squares.

1431. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Given circle O, and points A and B on circle O and not diametrically opposite. Variable secant MN passes through A and cuts circle O again at C. Variable secant RS passes through O, bisects arc BC, and meets MN at X. Find the locus of X.

1432. *Proposed by Frank M. Walling, Meadville, Pa.*

In traveling two miles, the rate of speed of a train in miles per hour is, at every instant, thirty times the distance traveled. What is the time required to travel the two miles?

1433. *Proposed by Nathan Altshiller, Court, University of Oklahoma.*

The sum of the squares of diagonals of the faces of a parallelopiped is equal to twice the sum of the squares of the edges.

1434. *Proposed by Maxwell O. Reade, Brooklyn.*

Construct a triangle given h_a, m_a, and t_c.

1435. *Proposed by Cecil B. Read, University of Wichita, Kansas.*

Prove that if a fraction a/b, where b is prime, is reduced to a circulating decimal such that the number of figures in the recurring period is even; then the sum of the first half of the figures in the recurring period added to the last half will consist entirely of nines.

NICOTINE, QUININE, STRYCHNINE, PARALYZE PLANT PROTOPLASM

Plant protoplasm is sensitive to the same drugs that affect the living stuff in the cells of human beings and the lower animals. This is indicated by experiments reported before the meeting of the American Society of Plant Physiologists by Dr. F. M. Andrews of Indiana University.

Dr. Andrews used the cells of a common water plant known as Elodea for his experimental material, because the ceaseless streaming motion of the protoplasm around their walls is easily visible under the microscope. When anything happens to the protoplasm, the motion stops.

Stoppage occurred in response to treatment with nicotine, strychnine, quinine, caffein and a number of other vegetable drugs of the group chemists call alkaloids. Nicotine was the most severe in its action, and only strychnine and brucine were ever stimulating in any concentration.

Pollen grains from a large number of plants were also used in the experiments. Pollen grains will normally germinate and send out their fertilizing tubes when placed in sugar solutions. But when the alkaloids were added the growth of the pollen tubes was very severely discouraged. This was especially the case when weak solutions of strychnine and quinine were used.

SCIENCE QUESTIONS

February, 1936

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio

What are your pupils talking about?
What do you think about the science in present day advertising?

Send in something. Help out the Editor—just address Jones, 10109 Wilbur Avenue Cleveland, Ohio.

SOME THINGS THEY TALK ABOUT

1. Cleveland had zero weather on Christmas Day. On Dec. 20, 1935, it snowed but scarcely froze.
2. Cincinnati (100 miles south) had a temperature of about five degrees below on Dec. 21, 1935.
3. They say ice formed in Chesapeake Bay during the Christmas holidays.
4. Niagara Falls, N.Y., was 12° above zero on the 22nd of December. An "ice bridge" formed below the falls.
5. The radio said Buenos Aires was 100°. (What would a B. Airian have said about his temperature?)
6. They start the school year in June in the Philippines to keep away from school in hot weather.
7. They say there was only one day between December 24, 1935, and Jan. 1, 1936, warm enough to go in swimming in Florida.

Aint This a Funny World

Champion Lie of 1935

By Jim Jordan of Chicago in the Annual "Ananias Sweepstakes" of the Burlington, Wisconsin, Liars' Club. (Not elected to the GQRA.)

"Two years ago the weather was so cold it drove a rat into our house for shelter.

"Do whatever I would, I could not catch it even with cleverly baited traps. Finally I hit upon the idea.

" 'The cold drove you in,' sez I to myself, 'and the cold will catch you.'

"I brought in our largest thermometer, putting a big piece of cheese beneath it. The next morning I had Mr. Rat.

"The mercury had fallen so low during the night it pinned him to the floor."

Spring Science Meetings

The Annual Meeting of North-Eastern Ohio Science and Mathematics Teachers will be held at Western Reserve Academy, Hudson, Ohio, in "sugar weather" when the maple sap is running.

It's worth coming a long ways to attend this meeting!

Last year it was on Saturday, March 16, 1935. This year it will be held on **Saturday, March 21, 1936.**

What other Spring meetings are being held elsewhere?

What is a Foot-pound?

737. *A member of the GQRA submits the following:*

Two recent "General Science" tests said the following about the measurement of work.

1. "A foot-pound is the amount of work done in lifting one pound one foot."

2. "A foot-pound is the work done when force causes one pound of matter to move through a distance of one foot."

We may ask these questions—

I. Which of these definitions, if either, is correct?

II. Is either definition satisfactory if we want to give the student a clear and general concept of this term (work)?

Up and Down

738. *By another member of the GQRA.*

Try this on your Superintendent. I did.

"A balloon, filled with hydrogen gas, is rising slowly through the air. Hanging from the balloon is a basket carrying a man, a bag of sand, a parachute, and a tank of oxygen. Classify all the articles mentioned, placing on one side the article or articles that tend to carry the balloon up and on the other those that tend to bring the balloon down."

Some Pupils' Questions

739. *The Questions below were submitted by Students in Riverside High School, Buffalo, New York. They are elected to the GQRA and assigned numbers—Ruth Fremming, No. 118; Bernard Strohm, No. 119; Margaret Hughes, No. 120; and Richard Juhasz, No. 121.*

1. Which is the heaviest, a can filled with cream, whole milk or skimmed milk? Explain.

2. What is the liquid used in the common thermometer seen on the street?

3. A piece of iron wire becomes "red-hot" when a current of electricity is passed through it. Account for this in terms of the Kinetic Theory and wave motion.

4. If the earth's heat comes from the sun, why does it get colder as we go up to high altitudes?

5. Why are the gondolas used in stratosphere flights painted black on the lower half and white (or aluminum color) on the upper half?

6. From the standpoint of the earth's gravitation how far is "up" and why?

7. If the earth receives only 1/2,000,000,000 of the heat of the sun, what becomes of the rest of it?

8. What becomes of the heat that is radiated out into space at night when the earth is cooling off?

9. If the days grow longer after Dec. 21st, why do the weeks following produce colder instead of warmer weather?

10. A boy weighs exactly 100 pounds as he stands on a very sensitive scale. He then takes a deep breath. Does the scale read more or less and why?

Decide this Enigma

740. *Submitted by Carl E. Heilman, Paulsboro, N.J. (GQRA, No. 55)*

A barber lives in a village in which he shaves all those, and only those, who do not shave themselves.

The question is: "Does the barber shave himself?"

DID READERS' DIGEST STEAL FROM US?

716. *Submitted by Leona Millard* (GQRA, No. 92) *as a "Vacation Question."*

A young man and his wife started from England for a vacation in the Swiss Alps. While climbing a mountain the woman fell over a cliff and was killed. The Swiss Coroner decided that the death was accidental and it was so reported in Continental papers.

Back in England a man read this newspaper report and informed the police that the husband had murdered his wife, which turned out to be the case.

What mistake did the husband make which caused him to be detected in murder?

John M. Michener, Wichita High School East, Wichita, Kansas (Elected to GQRA. No. 117) says—

"You will find this question in an article in the *Readers Digest* for some issue of last summer. The answer is also given in the same issue. It is practically the answer given in this last issue of SCHOOL SCIENCE AND MATHEMATICS by L. C. Formo except that the latter is in much greater detail."

Answer—"Undoubtedly. This kind of question appears and reappears at intervals. Maybe we copied unwittingly." *ED.*

THE PRINCESS AND SUITORS—RESTATED AND ANSWERED

720. *Answers and Restatement by Kenneth E. Anderson, Bronson High School, Bronson, Minnesota (Elected to GQRA, No. 122).*

I wish to submit the following restatement of 720, which appeared in the October number of SCHOOL SCIENCE AND MATHEMATICS:

A princess had twelve suitors among whom she refused to choose. They finally agreed to ride their horses to a wood 5 miles away and that she should wed the one whose horse would be the last to return to the castle.

They did as agreed but none would take the lead. They would ride for a distance and then ride back over the same distance. They finally encountered an old witch who solved their problem by whispering two words to each of the twelve suitors. Immediately they galloped towards the castle. What two words did the witch speak?

The answer is as follows: The old witch whispered, "Change Horses." Each suitor then was riding a horse which was not his own. If he managed to bring in one of the other suitors' horses ahead of his own he was thereby increasing the chances for his own to come in last. Thus it became a real race but each one not riding his own horse.

RADIATOR ANTI-FREEZE

730—*Anti-freezing Solutions for Automobile Radiators.* (A sheet given to teachers at Lincoln High School, Cleveland, Ohio, by B. F. Salisbury. *Elected to GQRA. No. 123.*)

Calcium chloride preparations are sold under a variety of trade names. They have a corrosive action on engine jackets, solder, and aluminum as

used in manifolds. This is the typical effect of nearly all salts as used in anti-freezing solutions.

Distilled glycerine does not cause leaks except in so far as their solvent action, tending to loosen scale, may uncover holes or cracks in the metal. Anti-leak compounds will only temporarily stop this type of leak. Glycerine shrinks rubber tubing swollen in service and this may cause leakage. Except for its cost and the tendency to promote leaks distilled glycerine is a satisfactory anti-freeze solution. Where long trips are involved it is probably the most satisfactory material to use.

Denatured alcohol is cheapest and best for the average driver. The following table will indicate the proportions of alcohol and water required to replenish a radiator solution to maintain a constant percentage of alcohol.

Radiator solution		Replacement solution	
Denatured alcohol	Water	Denatured alcohol	Water
20% (by volume)	80%	75%	25%
40%	60%	87%	13%
50%	50%	90%	10%

Proportions and corresponding freezing points.

Denatured alcohol	Water	Freezing Temperature
1 quart	4 quarts	19° above zero F.
3 quarts	7 quarts	10° above zero F.
2 quarts	3 quarts	2° below zero F.
2 quarts	2 quarts	18° below zero F

At the temperatures indicated a sludge will form. Solid freezing is several degrees lower.

180 proof alcohol is 90% alcohol and 10% water. 188 proof alcohol is 94% alcohol and 6% water.

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BOOK REVIEWS

The Story of the Plant Kingdom, by Merle C. Coulter, Professor of Botany, The University of Chicago. Cloth, pages ix+270. 15×23 cm. 1935. The University of Chicago Press. Chicago, Ill. Price $2.50.

"Four years ago the University of Chicago adopted a new college curriculum. It was hoped that this curriculum would succeed more fully than had its predecessors in 'rounding out a respectable minimum of general education' during the Freshman and Sophomore years." The core of this "respectable minimum of general education" is provided by four one-year courses, respectively, introductions to the "Humanities," the "Social Sciences," the "Physical Sciences," and the "Biological Sciences." This book by Professor Coulter was written to supply the need for a text, or introduction to the science of Botany for the one-year course, in the "Biological Sciences."

There are twenty chapters in the book covering the field of botany—in other words, the plant Kingdom. Twelve of these twenty chapters are regarded as "indispensable" for the "general education" aimed at, but the entire twenty chapters are expected to be read to give a complete picture of the plant Kingdom.

This "Story of the Plant Kingdom" is really what the title presupposes, a story of the plant kingdom. It is more than an ordinary textbook in that the "story" is told in a scientific spirit and manner. The presentation is simple, for it is certain that the larger portion of the student audience will not have planned to carry the study further. The use of the technical terminology of the science is minimized to suit this condition, where the entire student body is required to take the course.

We feel that Professor Coulter has succeeded admirably in his presentation of his share of the "introductory" courses. The text is clear, simple and straightforward. To clarify, explain, or amplify various points in the presentation, footnotes are freely used. In our opinion these notes add much to the text. Teachers of botany in high schools will find the book of great use in giving more life to their courses. It is a departure in textbook making that is to be highly commended.

W. WHITNEY

The Algae and Their Life Relations, by Josephine E. Tilden, Professor of Botany, University of Minnesota. Cloth. Pages xii+550. 15×23.5 cm. with 257 figures in black and white—many of them full page—and one plate in colors. 1935. The University of Minnesota Press. Minneapolis. Price $5.00.

This is a book for advanced students in botany. It will be helpful to supplement lectures and laboratory and be used as a reference book for experienced investigators. The book is the result of a life's work by Miss Tilden, who is one of the best known authorities on all types of algae. It shows the results of a very careful and thorough study of the algae, as may be readily seen by the contents of the book and by a bibliography of more than 500 students of the algae.

The earlier chapters are largely devoted to the description of the algal plants. Their relations to other plants and animals and their distribution and economic uses are discussed in later chapters. Some important and interesting questions are broached with respect to the phylogeny of the algae. "Are there connecting links between the several classes of algae?" "Is there a relationship between any of the classes of algae and the higher plants, or between the algae and the primitive or the higher animals?"

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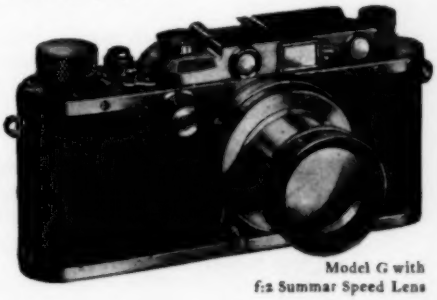

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"What is the probable place of origin or point of unusual development of any particular algal group with respect to the geological history of the world?" The author believes that the existing blue-green algae have arisen from "pioneers on the frontier of life," and that ancestral forms came into being during the period of weakest illumination.

Any serious student of botany, or teacher of botany will be amply repaid by owning and studying this volume.

W. WHITNEY

A Textbook of Physics, Volume V, Physics of the Atom, by E. Grimsehl; Edited by R. Tomaschek, Director of the Physical Institute, Technical College, Dresden; and Authorized Translation from the Seventh German Edition by L. A. Woodward, Leipzig. Cloth. Pages xiv+474. 14.5×22 cm. 1935. Messrs. Blackie and Son, Limited, 50 Old Bailey, London, E.C.4. Price 17s. 6d. net.

Altho this book stands as the fifth volume of a series that has run through six previous editions, it is practically a new book. Most of the subject matter has been developed within very recent years. The plan of emphasizing experimental facts and introducing theory only as needed to properly explain the phenomena discovered, which was used in the previous volumes of this set, has been continued by the author. The historical plan of treatment is followed but only sufficient "ancient" history is reviewed to give the proper understanding of the modern discoveries in the field of atomic physics.

The author has kept constantly in mind the difficulties of the student and has made copious use of diagrams, graphs and pictures. Explanations of phenomena are given on the basis of classical physics to the point where the classical laws break down. The Rutherford-Bohr atom model is used to give an understandable first approximation and wave mechanics introduced where it assists in giving closer agreement with experimental facts. In the use of the mathematics needed as a basis for quantitative discussion, the author indicates the steps in the development and calls attention repeatedly to the assumptions made.

The content of the text is indicated by the chapter headings, which are as follows: The Electrical Structure of Matter, The Nucleus, Light and Matter, Waves and Corpuscles, Spectral Lines and the Structure of Atoms Containing More Than One Electron, Molecular Structure, The Structure of Solids and Liquids, Electrodynamics of Moving Media, and Matter and Energy in the Universe. Each chapter has been made as nearly independent of the others as possible but the inter-relations are shown, and the contribution of each toward building the modern picture of the electrical nature of matter is clearly given. The text is admirably adapted for use as a first course in modern physics or as a supplementary text.

G. W. W.

Practical Shop Mathematics. Volume I Elementary. By John H. Wolfe, Supervisor of Apprentice School, Ford Motor Company, and Everett R. Phelps Ph.D., Associate Professor of Physics, Wayne University. Pages (v–xi)+331. First Edition 1935. McGraw-Hill Book Company, Inc. New York and London.

This book and its continuation, volume II, are based on the loose leaf printed sheets used at the Apprentice School of the Ford Motor Company. It is designed not only for Vocational and Trade Schools but also to be used in all high schools to replace the geometry course for students who do not intend to go to college.

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